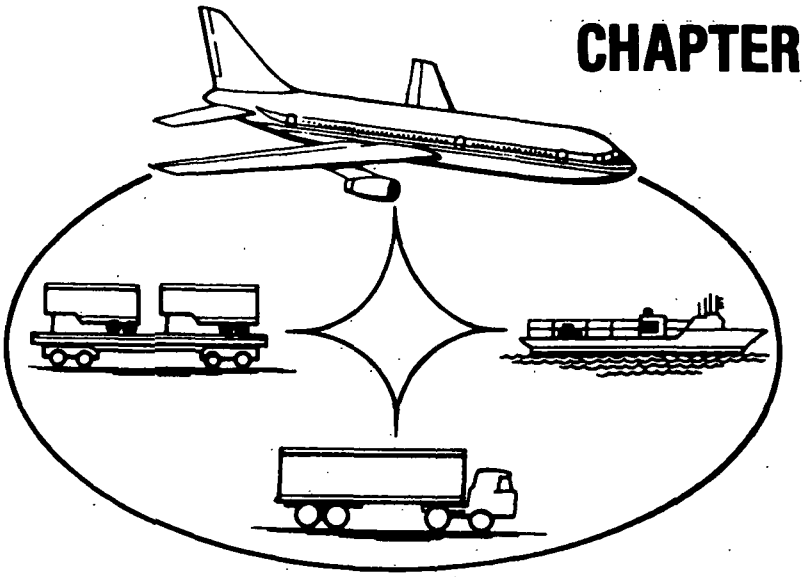
CHAPTER 4



PUBLIC POLICY

CHAPTER 4

PUBLIC POLICY

Introduction

Public policy issues which relate to the air cargo integrated system are basically issues of energy, economics, and politics. The energy picture must be displayed; the economic considerations must be explicated; and the political ambiance in which decisions occur must be defined if we are to comprehend the global significance of the ACIS. These three concerns are not separate in fact, and not easily separable in theory. Therefore, even though the separate sections in Chapter 4 may focus on one of the three central aspects, the discussions are not "topic tight".

Section one of our chapter addresses American political culture as it relates to the ACIS. Section two is most easily characterized as the economics of materials and energy. Section three relates the concerns of the preceeding section to policy issues. Capital formation is the primary focus of Section four. Section five addresses military needs and foreign policy. Finally, in Section six, we discuss futures and impacts of the ACIS.

4.1 PHILOSOPHY OF GOVERNMENTAL ACTIVITY

It appears that an integrated air cargo system cannot be put in place without government playing a facilitating role. This facilitating role includes the establishing of an appropriate set of regulations; institutions for implementing those regulations; and the creation of an economic climate wherein business can function in conformity to those regulations. In playing its facilitating role, the government must see that the public interest is served and thereby legitimate its involvement.

While there exists a wide range of opinion about what is and is not in the public interest, consensus prevails among Amercians regarding the necessity of provision for public goods. In explicating the notion of public good John Rawls says ". . . the main idea is that a public good has two characteristic features, indivisibility and publicness. That is, there are many individuals, a public so to speak, who want more or less of this good, but if they are to enjoy it at all, they must enjoy the same amount. The quantity produced cannot be divided up as private goods can and purchased by individuals according to their preferences for more and less. There are various kinds of public goods depending upon their degree of indivisibility and the size of the relevant public." (ref. 1) The consequence of indivisibility and publicness is that public good must be provided for through the political process rather than the market. Thus if it can be shown that the public good derived from an integrated cargo system is worth the public portion of the money used to put such a system in place then the government is justified, on these grounds alone, in acting to implement the ACIS.

When we attempt to access the public good that will be derived from the ACIS, we are immediately confronted with the difficulty of forecasting future trends and guarding against undesirable outcomes. That is, we want to have a system which will be politically and economically acceptable if things go as planned, but we also want to avoid catastrophic consequences if things do not go as planned. We ask ourselves, "What will happen if the economy grows much faster, or much slower, than expected -- What are the disbenefits associated with overcapacity and undercapacity?"

We do not view the system here proposed as a conservative one. We have already advocated major changes in the terminal system, in the structure of regulatory agencies, and other facets, and have foreseen a major and important industry, growing where only a few years ago there was only a minor business; a poor relation of passenger carriage. On the other hand, we have not adopted the views advocated by some that there should be, by the turn of the century, huge distributed-load aircraft or other major technological changes involving truly massive public and private investment. Is this being unduly conservative? The answer to this question lies in viewing the consequences of misjudgement, and forseeing corrective measures.

Figure 4.1 introduces the concept of consumer's surplus (ref. 2). The curve labeled D is the hypothetical demand curve. Following the curve from right to left we see that as the price increases, the demand goes down. The curve labeled C represents the cost of service. At some point, curve C crosses curve D. In an unconstrained market, we would expect the quantity of services available to be determined by the intersection of curves C and D.

If the capacity of the system exceeds market demand, then the quantity of consumer surplus benefits is little affected and the disbenefits of the excessively large system will be borne in part by the government. But, if capacity is less than market demand then the mechanism utilized to bring demand into line with supply is worthy of analysis in terms of public benefits.

If market demand exceeds capacity and users are accomodated on a first-come, first-serve basis, then the overloading of the system will create a population of randomly selected dissatisfied users. These users will be less inclined to use the air transport system and therefore quantity of goods moved will decline. The randomly distributed instances of poor service has the effect of increasing the cost to the users. (See Figure 4.2)

If, instead of relying on customer dissatisfaction to limit demand, a tax is placed upon the system which has an equivilant constraining effect, the picture changes considerably. In Figure 4.3, the price to the user is shifted With the addition of the tax. The result is that most of the consumer surplus lost due to undercapacity is transferred to the government and is available for investments to correct the situation or for other public uses.

Since the government will presumably be able to impose a tax at its discretion, should market demand exceed capacity, it follows that in planning air cargo futures, the federal government, in its role as guardian of the public interest, should opt for the smallest practical system. The cost of overcapacity cannot be recovered while the cost of undercapacity can be made to translate into considerable public benefits.

In trying to fulfill the governments role, decision makers must work within the framework of American political culture (ref. 3). It is therefore appropriate to look at four specific features of American political culture which define parameters for decision makers (ref. 4). The four features are:

1. Belief in a limited role for goverment in relation to economic enterprise

2. Distrust of centralized decision making in government

3. Ethnocentric orientation toward institutions

4. Emphasis upon pluralistic public decision making

It is plausible to expect that the American public and public sensitive decision makers will emphasize a limited role for government in relation to the ACIS. Therefore, such options as creating a public corporation to

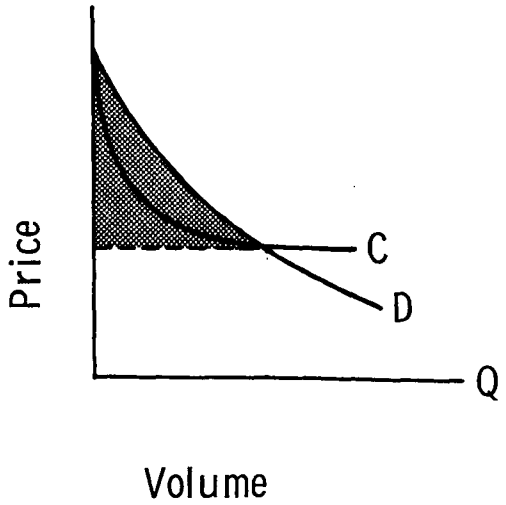
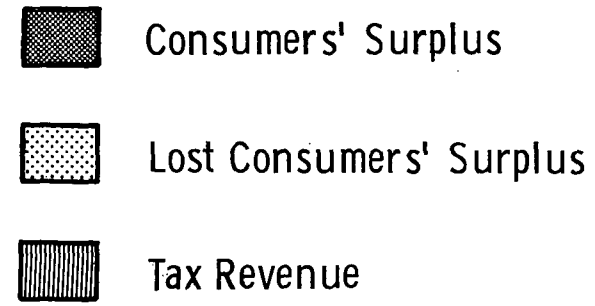


Figure 4.1 VOLUME REGULATING MECHANISM



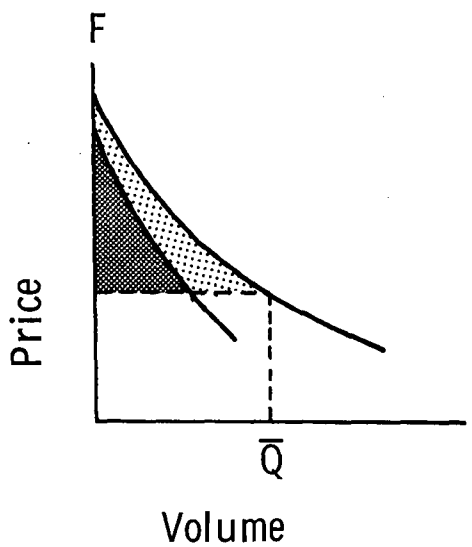


Figure 4.2 VOLUME REGULATING MECHANISM

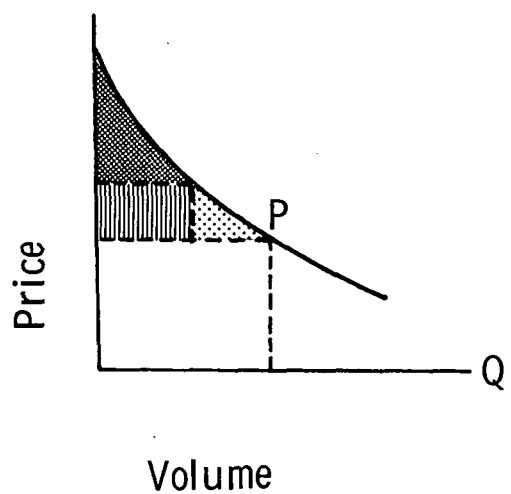


Figure 4.3 VOLUME REGULATING MECHANISM

manufacture advanced aircraft may be difficult to exercise. It can also be expected that there will be considerable resistance to the formation of international companies for either aircraft manufacturing or freight movement. Therefore, capitalization will be difficult and the efficiencies achieved by single waybill difficult to realize in the international sphere.

American political culture also operates to produce a diffuse decision making process wherein each administrative agency jealously guards its prerogatives (ref. 5). This factor tends to further augment the likelihood that non-optimal decisions will be made concerning the ACIS unless a concerted planning effort is made.

The diagram in Figure 4.4 attempts to identify the principal participants in the policy making process that involves a national decision on advanced air cargo aircraft. As the figure indicates, input concerning policy initiative comes primarily from aircraft manufacture, the military, and commercial group lobbies. One can expect lesser involvement by government agencies such as EPA, DOT, DOE, NASA, etc., and state and local government. (ref. 6) All such interests may influence the introduction of legislation and the adoption of regulations relating to the ACIS. Once the legislative process is underway, congressional staff members, lobbies, and the GAO have considerable impact (ref. 7).

The systematic implications of this diffuse and pluralistic process are that a vast complex of goals and interests will have to be taken into account when public policy is formulated with respect to the ACIS. A reconciliation of all interests may not be feasible and unhappy compromise decisions may be made. Under these conditions, optimal solutions may be difficult. Therefore, persons looking for the best decision with respect to the ACIS could be somewhat disappointed.

The combined effects of the legitimating rationale which must be offered for the development of the ACIS and the political ambiance, or culture, wherein decisions about developing the system must be made are such that undesired outcomes are likely unless concerted and clear planning is undertaken. We must decide what we want to do in some comprehensive fashion, but the current energy situation increases the risk of resource commitment. Therefore, we now turn to a consideration of natural resources and the role of transport in the U.S. economy.

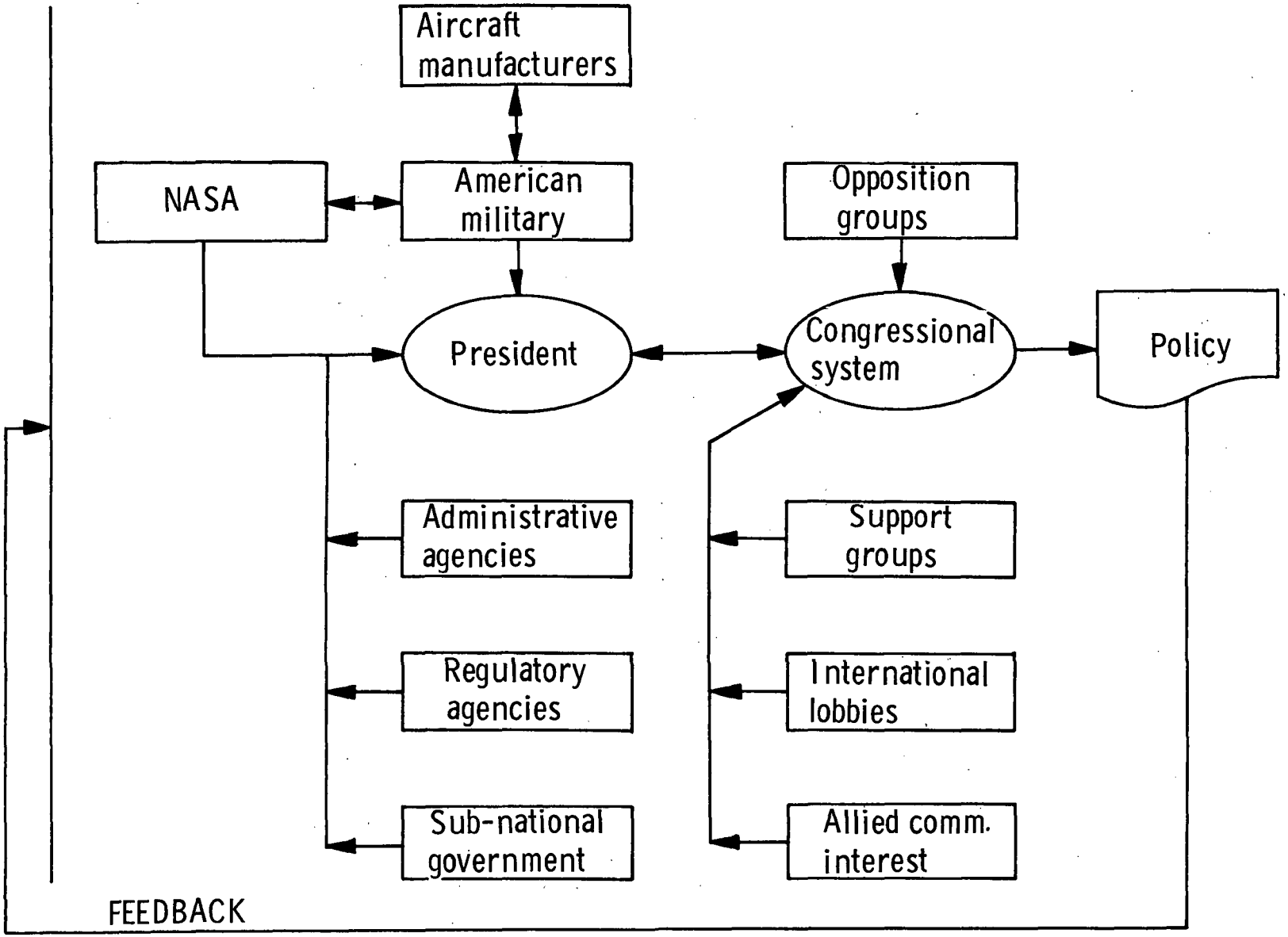


Figure 4.4 NATIONAL POLICY ON ADVANCED AIR CARGO - A SCHEMATIC VIEW OF POLICY PARTICIPANTS

4.2 MINERAL RESOURCES AND THE AIR CARGO INTEGRATED SYSTEM

Introduction

The need to use many different natural resources (Table 4.1) in the actual construction of the Air Cargo Integrated System (ACIS) is certain. Therefore, while it is true that the actual percentage of most natural resources to be used will be small, this small use must be determined so an awareness of the possibility that any particular material will not be available due to depletion or administrative regulation is known.

During the OPEC embargo, the amount of petroleum available to the airlines was drastically curtailed. When shortages of non-renewable resources (NRR) occur, it is logical to assume that the use of these NRR will likely be curtailed. By attempting to determine how much NRR are used by the airline industry and the ACIS specifically, and trying to implement conservation techniques now, it may be possible to avoid critical shortages during the planning period.

The number of different natural resources are great. This study will examine only those natural resources where shortage is likely to occur during the time frame of the overall study. This narrows the natural resources to be studied to certain mineral resources (Table 4.1).

This analysis separates the fuel and nonfuel mineral resources. Although there are many similarities in the basic characteristics and policy implications of fuel and nonfuel minerals, today's market, with its prospects of massive transformation in the fuel sector, introduces important differences that warrant special treatment.

4.2.1. Non-Fuel Mineral Resources

The five major metal minerals used by the U.S. Transportation sector in 1970 are shown in Table 4.2. Although these figures include general aviation aircraft as well as the major airlines and military aircraft, it is evident that the aircraft industry, especially the air cargo industry, uses a substantial amount of mineral resources.

The different minerals used in aircraft are of a greater range than in other transportation modes due to the unique operating conditions. Aluminum, steel, and special alloys of titanium and magnesium constitute more than 70 percent of most aircraft by percent of the total weight (Table 4.3). In addition, a variety of other minerals are present in smaller, but certainly not less important quantities: beryllium, boron, cadmium, carbon, chromium, cobalt, graphite, gold, lead, molybdenum, nickel, silver, tin, tungsten, vanadium, zinc, and zirconium.

Table 4.1

NATURAL RESOURCES

- Air
- Minerals*
  - Fuels*
    - Hydrocarbon
    - Non-hydrocarbon
  - Metallics*
  - Non-metallics*
- Aesthetics
- Product of Land
  - Crops
  - Livestock
  - Space
  - Timber
  - Water

* Those natural resources to be studied in this section of the ACIS study.

Table 4.2

METAL MINERAL RESOURCE USE BY
THE UNITED STATES TRANSPORTATION SECTOR
(1970 DATA)

Wt. in 10^5 Metric Tons	Steel		Aluminum		Copper		Lead		Zinc	
	%	wt.	%	wt.	%	wt.	%	wt.	%	wt.
Highway Vehicles	19.6	20.19	11.2	0.67	8.2	0.25	00.0	0.60	19.5	0.39
Aircraft	2.2	2.27	6.1	0.37	3.0	0.09	4.3	0.04	4.1	0.08
Ships	1.0	1.03	4.6	0.28	0.8	0.02	1.2	0.01		
Others	4.0	4.12								

NOTES: Copper includes alloys. Lead consumption includes amount used in anti-knock compounds and replacement batteries.

Sources: Kay and Mirrlees, 1975 (ref. 7) and Leach, 1972, (ref. 8).

Table 4.3

THE COMPOSITION OF VARIOUS AIRCRAFT
(Percent by Weight)

	Aluminum Based Alloys	Steels	Titanium Alloys	Copper	Magnesium Alloys	Nickel Based Alloys	Non-Metallics
B.A.C. 111[2]	54-56	25-27	0.1-0.5	1.5-2.5	1.0-1.5	1.0-1.5	
DC 3	80[3]						20 (15% wood fibre)
Concorde	71[1]	16	4			2	7
747	75[3]		15				10
Unnamed Supersonic	48.2	21.8	8.0	2.6			6.6
Unnamed Subsonic	55.6	26.3	0.5	2.1			12.7

Sources: Edwards, 1970; Alexander, 1972; and Goldsmith, 1974; Vaccari, 1969.

Note: 1. The aluminum alloy contains 2% copper, 1.5% magnesium, and 1% nickel.
2. Figures refer to materials bought for the aircraft and include that on the floor as waste.
3. Percent includes both aluminum based alloys and steel.

The choice of materials is influenced more by the technical properties of the materials than by price considerations. This is due to the small proportion of the total cost of an aircraft that materials make up. Moore (ref. 8) states that the cost of a 747 would only increase by 16 percent if the materials used increased five fold.

4.2.1.1. Availability of the Non-Fuel Mineral Resources for the ACIS

The U.S. is nearing the end of the second of a three stage development in mineral resources. From a past period when the U.S. was abundantly supplied by itself and the world, to the present period when the U.S. must share the world's supply more uniformly with the rest of the world, to the near-future period where the world's mineral supplies are not adequate for the world and some countries must do without depending on their military, resource, and/or economic strength. "The outlook is for an acceleration of demand, increasing difficulty of supply, and increasing challenge to technology, and an upward pressure on prices." (ref. 9)

Table 4.4 illustrates the minerals, divided into metals and non-metals, needed for the three parts of the ACIS system. Their importance to each part of the system is indicated by a number sequence: 3 for important, 2 for moderate importance, and 1 for low importance. A letter indicates those minerals which may have supply problems in the 1990-2015 time period due to possible cartel action (x), price difficulty (y), or depletion-world (z) and U.S. depletion (w).

The three possible types of supply problems were investigated and determined by using the following seven characteristics as well as the author's previous research:

1. The proportion of imports to domestic consumption
2. Vulnerability to coordinated producer action
3. The availability of alternative materials
4. Development of and the amount of domestic resources
5. Imposition of conservation measures
6. The balance of payments impact
7. The capital requirements for domestic and alternative foreign resource development

In dollar value, the U.S. produces about 85 percent of its total mineral needs; yet, despite this success, the U.S. has not been able to correct its mineral deficiencies and has fallen steadily behind in its ability to supply its needs. Of 40 primary minerals needed by the U.S., 20 of them are in jeopardy of being depleted. Approximately 1/3 of the country's net supply of primary metals and metallic ores are imported. The increasing problem of the

Table 4.4

MINERAL RESOURCES NEEDED FOR THE ACIS

General Type of Mineral	Specific Type of Mineral	Aircraft Needs	Terminal and Ground Support Needs	Supply Problem
Metals				
Iron	Iron Ore	2	3	
	Steel	3	3	
Iron Alloy	Manganese	2	1	x
	Chromium	3/2	1	xw
	Nickel	3/2	3	x
	Molybdenum	2	2	
	Cobalt	2	2	x
	Vanadium	2	1	
	Tungsten	3/2	2	x
Base	Copper	3	3	y
	Lead	3	3	z
	Zinc	3	3	y
	Tin	3/2	2	xzw
Light	Aluminum	3	3	x
	Magnesium	3	3	
	Titanium	3	1	x
Precious	Gold	2	1	
	Silver	1	1	zw
	Platinum	2	1	zw
Rare	Uranium	*[1]		
	Beryllium	2	1	
	Zirconium	3/2	1	
	Mercury	2	1	xzw

Table 4.4 (continued)

MINERAL RESOURCES NEEDED FOR THE ACIS

General Type of Mineral/s	Specific Type of Commodity	Aircraft Needs	Terminal and Ground Support Needs	Supply Problem
Non-metals				
Ceramic	Clay	1	2	
Insulant	Asbestos	2	1	z
	Mica	2		*
Gas	Helium	*[3]	*[3]	z
	Hydrogen	*[4]	*[4]	
	Nitrogen	1	1	
	Oxygen	1	1	
Building	Sand and Gravel		3	
	Limestone		3	
	Cement materials		3	
Chemical	Sulfur		1	
	Salt		2	
Pigment and Filler	Clay	1	2	
	Diatomite		1	
	Barite	1	1	y
Artificial	Plastics	3	3	
	Glasses	2	3	
	Composites	*[5]		

Notes:
1. If a nuclear aircraft is developed uranium will be 3 to 2 rating, otherwise uranium will not be a factor.
3 & 4. If hydrogen is used as a fuel in future airplanes hydrogen will become a 3.
5. At the present it is 1 but as composites become used more for aircraft construction it will develop into a 3.

U.S.'s developing deficit of minerals is illustrated in Figure 4.5. Specifically the reserve situation is somewhat tight or critical for several minerals. Asbestos, chromium, mercury, and tungsten will be near depletion by 2015. Price increases and difficulty of supply will occur with aluminum, copper, gold, lead, manganese, nickel, and silver. There is a possibility of short supply of barite, iron, mica, phosphate, thorium, titanium; vanadium, and zinc; the extent of the shortage depends on technological supply.

Therefore, the U.S. will become increasingly dependent on foreign sources. Assuming no political problems with obtaining necessary minerals, what is the likelihood that the world's mineral supply will be able to meet the United States needs? Except for asbestos and mercury, the possibility of the world running out of necessary mineral resources from 1990 to 2015 is very unlikely. However, there is a strong possibility of political controls being placed on certain critical minerals. Therefore, it is not the problem of depletion but one of political and in some cases economic controls that will cause the U.S. and the ACIS problems in obtaining the necessary minerals for development.

4.2.1.2. Solutions to the Mineral Supply Problems

What can be done about the U.S. mineral supply problem?

Besides the advancement of technology to use lesser grades of minerals, there are five other possible solutions to the U.S. mineral problem: (1) substitution of abundant for scarce minerals and in certain situations just the reverse, (2) stockpiling of possible problem minerals, (3) recycling of the mineral content of products, (4) changes in product design to increase the useful life of a product, and (5) develop new techniques to find undiscovered mineral deposits. For depletion, true depletion, where our technology cannot make lower grade "ores" feasible to utilize, substitution is a possible solution. Table 4.5 shows some of the more important materials and the possible substitutes that will be used in the construction of the ACIS. Of course, where a mineral has specialized technological applications in which a multiplicity of properties is required as will be the case in the use of many of the minerals for the ACIS, available substitute materials will be more limited than in many other industries.

To reduce the risk of being cut off from necessary mineral supplies, stockpiles of many minerals should be maintained. They may be developed by individual industries as well as the national government for the reality of world trade dictates that industries dependent in significant measure on imported minerals should try to carry substantial inventories of needed raw and semiprocessed materials.

The efficiency of recycling to decrease the U.S.'s mineral supply problems depends on the particular mineral; aluminum, steel, copper, and lead are the leading minerals to be recycled. However, until transportation regulations and federal economic controls are revised, it is unlikely that recycling of minerals will increase for any of these minerals.

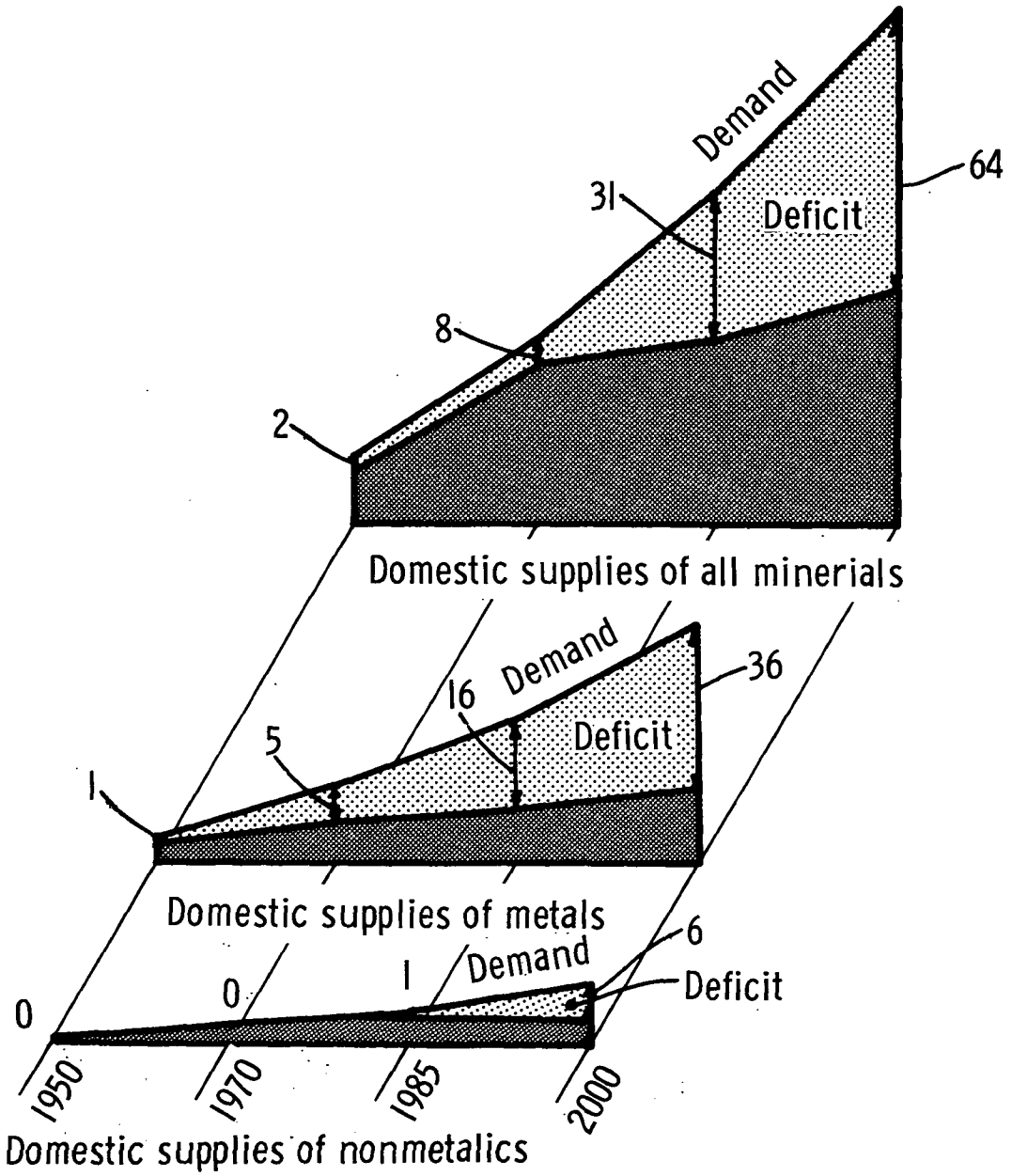


Figure 4.5 THE UNITED STATES INCREASING MINERAL DEFICIT (Source: Adopted from Cameron, 1973, (Ref. 18).

Table 4.5

SUBSTITUTES FOR SELECTED MINERALS

Mineral	Reserves of Principle Substitute Minerals (Years of supply availability)			Other Substitute Products
	Less than 30	30 to 60	100 or more	
Bauxite	Copper Titanium		Steel	Plastic Wood
Chromium		Nickel Molybdenum	Vanadium	
Cobalt		Nickel		
Copper		Aluminum	Steel	Plastics
Lead	Copper Mercury Silver Titanium Zinc	Nickel	Cadmium Zinc	Plastics Rubber Tile
Platinum		Gold		
Tin	Copper Lead	Aluminum Gold	Steel	Glass Paper
Tungsten	Titanium	Cobalt Nickel Molybdenum	Tantalum	
Zinc		Aluminum	Cadmium Magnesium Steel	Plastics

There are many serious problems concerning the U.S.'s mineral resources. Only a few have been addressed in this report; however, Table 4.6 attempts to illustrate many of the problems, which due to space and time constraints, were not addressed in the text.

In view of the geologic and geochemical constraints on the occurrence of economic deposits of minerals and energy resources, and the advanced nature of present exploitation techniques, we must conclude that such resources are finite. On the other hand, the question "When will we run out?" indicates a misunderstanding of geologic resource limits. The world will not run out of many mineral resources, but they will become more expensive and difficult to obtain.

4.2.2. Fuel Resources for the ACIS

There are many sources of fuel for the ACIS; however, at the present time only natural hydrocarbons, specifically petroleum derived kerosenes, are used as fuel in aircraft. Because of this situation, discussion of petroleum resources is an appropriate starting point for this section.

4.2.2.1. World Petroleum

Energy is the lifeblood of an industrial society. It substitutes the power of matter for the power of man. Industrial development and the growth of revenues are linked to the use of various sources and forms of energy. Much of the energy produced originates from fossilized hydrocarbons which are completely consumed in their first using. The amount of available fossil energy, its cost, and the mastery of technologies of extraction, treatment, and dispatching to make it readily available are all factors of power and wealth. Therefore, one of the most critical questions facing the world is: how long will the production of oil continue to be the most important source of energy?

It is hard to overdramatize the importance of oil as a world energy source. If the supply of petroleum could continue to increase indefinitely, the world would continue to use it as the major source of energy; however, because petroleum is a non-renewable fuel it will be depleted in the future. This situation is the principle reason for the "energy crisis". To understand this crisis, it is necessary to understand some of the underlying facts and data.

From the early 1940's to 1975 the estimated crude oil world resources have grown from 400×10^9 barrels to 2000×10^9 barrels (ref. 10). However, the 200 figure was first quoted in 1959 and it has not varied more than 20 percent since that time. The amount of reserves totaled between 600 and 700 billion barrels. Of this amount, 80 percent is in OPEC countries and 80 percent of this amount is in the Middle East (ref. 10). These estimates only include those resources recoverable at current prices and with current technology and therefore include oil recoverable by primary production plus oil recoverable by secondary or tertiary recovery where the potential has been evaluated and facilities are planned.

Table 4.6

MINERAL PROBLEMS: 1976 TO 2015

Key to numbers:

4 = Very serious
3 = Serious
2 = Moderate
1 = Minor
No number = No problem

	Aluminum	Asbestos	Beryllium	Cadmium	Chromium	Clays	Cobalt	Columbium	Copper	Gold	Graphite	Iron Ore	Lead	Magnesium	Manganese	Mercury
World resource inadequacy, by 2015		4								2	2					
U.S. high-grade resource inadequacy, by 2015	4	4	1	4	4	1	3	4	2	4	3	4	2		4	
U.S. low-grade resource inadequacy, by 2015					4		2	2			2				2	
U.S. reserve inadequacy, by 2015	3	4		2	4	2	3	4		2	4	1	2	4		
U.S. productive capacity inadequacy (mine or well)	4	4	1	2	4		3	3	1	1	4	2	1	4	2	
U.S. productive capacity inadequacy (smelter or processing plant)	2		1		2		3		1	1		2	1	1	1	2
Significant energy use	4				2	3			2			3		2	1	
Inadequate recycling			2	2	2	2	2	2	2			2		2	2	
Inadequate substitutes	3	4		1	4		3		1	1	3	1	3		3	2
U.S. foreign exchange drain	4				1				2	2		3				
U.S. vulnerability to foreign disruptions	3	3			4		4	2			3	2				

Table 4.6 (continued)

	Mica	Molybdenum	Nickel	Phosphates	Platinum Group	Sand and Gravel	Silver	Strontium	Tellurium	Tin	Tin (Rutile)	Tungsten	Vanadium	Zinc	Zirconium
World resource inadequacy, by 2015							2								
U.S. high-grade resource inadequacy, by 2015	3		4		4		4		4	4	4	2	4	4	
U.S. low-grade resource inadequacy, by 2015	2			2						3					
U.S. reserve inadequacy, by 2015	3		4		4		2			4	4	2	2	2	
U.S. productive capacity inadequacy (mine or well)	2		4				2	2			4	3		2	
U.S. productive capacity inadequacy (smelter or processing plant)			3				2					1		2	2
Significant energy use															
Inadequate recycling		2	2							2		2		2	3
Inadequate substitutes	2	2	2		3	1	2	2		1	1	2	1	2	2
U.S. foreign exchange drain			2		2		2			2	1			2	
U.S. vulnerability to foreign disruptions			2		4		2	3		2	3			2	

Adapted from Morgan, 1977, p. 17, also references 20, 21 and 22.

To increase the estimated total petroleum resources, it will be necessary to find a completely new source region for petroleum. Two areas that have been proposed are the deeper portions of the earth's crust and the ocean bottoms. The first is very improbable as commercial quantities of crude oil do not occur at depths greater than 20,000 feet due to the temperatures and pressures associated with such depths (ref. 11).

The second, the ocean bottoms (not including the ocean's shelfs and slopes), is more likely because the seabed has yet to be adequately explored geologically. However, there is the problem of developing the technology and industrial means to exploit petroleum which is beneath an average of 15,000 feet of water.

If new deposits are found, the very long lead times required to develop wholly new petroleum reserves requires that planning be done now (ref. 12, 13, and 14). Even longer lead times are needed to plan, finance, and conduct research into new and improved methods of seeking the hard-to-find deposits of hydrocarbons that will be needed by future generations.

It is also very unlikely that new deposits will increase our overall petroleum resources greatly because a very large percentage of the total petroleum found is a very small percentage of all known accumulations. More than 85 percent of the world's hydrocarbon production plus reserves occur in less than 5 percent (238 fields) of all producing accumulations. Even more remarkable, 64 percent of the hydrocarbons (petroleum and gas) occurs in slightly over 1 percent of all fields -- the 55 "supergiants" (a billion barrels more)(ref. 15) (Table 4.7).

Approximately 60 percent of all petroleum found outside communist countries is located in an area some 800 by 500 miles in the Middle East. The likelihood that such a prolific oil-bearing region will be found again appears small. Future additions to reserves are more likely to be obtained by improved recovery techniques. The percentage of oil that can be recovered varies from field to field (10 to 80 percent) but the general average is 30 to 50 percent. Recovery rates will improve gradually; starting small but increasing over the next 25 years.

With limited supplies of petroleum being a reality, we must realize it is essential that we determine when the change from a petroleum based economy will occur. This necessitates an understanding of how to determine the quantity to be used and how fast this use will occur. There are seven basic factors that interrelate to answer this question:

1. World energy price
2. World economic growth
3. National policy response
4. Petroleum discoveries
5. Production limits
6. World demand
7. Type of replacement fuel

Using the above factors, several studies have tried to predict the future of petroleum. Hafele and Sassin (ref. 16) compared a projected population growth rate to world per capita energy use and determined that all oil and coal

Table 4.7

APPROXIMATE SIZE OF WORLD OIL FIELDS

	Number of Fields Discovered	Estimated % of Non-Communist World's Reserves
All fields	30,000	100
Fields greater than 0.5 billion bbl recoverable reserves	240	73
Fields greater than 10.0 billion bbl recoverable reserves	15	34
Four largest fields[a]	4	21

[a]Ghawar (Saudi Arabia), Greater Burgan (Kuwait), Bolivar Coastal (Venezuela), and Safaniya-Khafji (Saudi Arabia/Neutral Zone). Source: Martin, 1977, p. 40 (ref. 23).

would be used up between 2030 and 2064 assuming these two energy sources were all that were used and a 5KW/capita energy usage occurred. Allen (ref. 17) assumed that there are 2100 billion barrels of natural crude oil left. He determined that (1) at present world consumption rates, oil will last until 2054, (2) continuing present day growth at 5 percent, oil will last until 2004, and (3) if growth declines to zero by 2000, oil could last until 2023. Martin (ref. 23) determined that the end of the growth era in oil production is probably no more than 15 years away. Potential oil demand in the year 2000 is unlikely to be satisfied by crude oil production from conventional sources (Fig. 4.6).

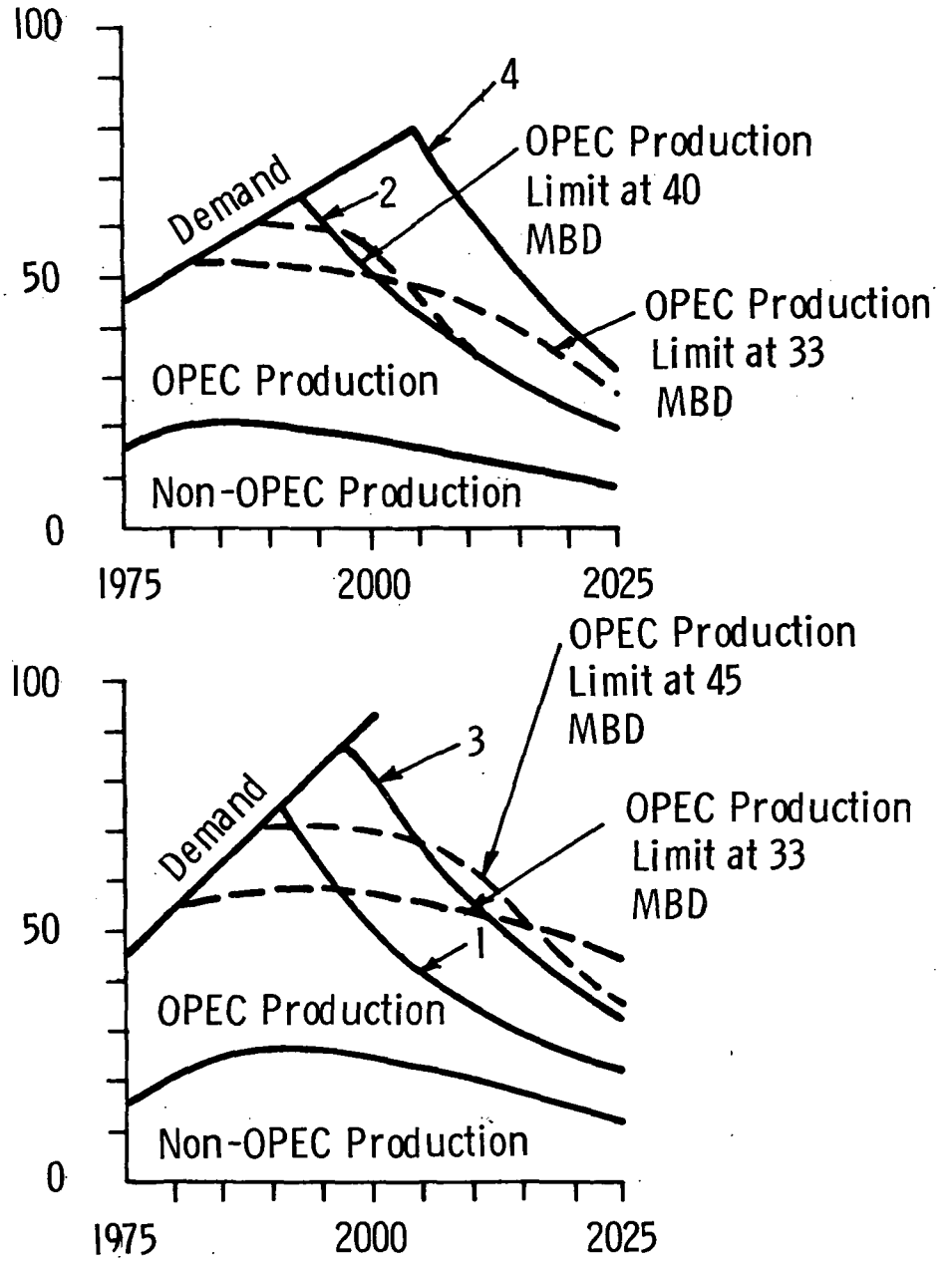
It is imperative that the world prepare to adjust to a declining oil supply in the near term (1990-1995). "There may be additional major oil discoveries or much higher recovery factors than have been assumed, but such favorable developments would only delay, not remove, the problem. Nations that continue to increase their oil consumption in the hope that more optimistic estimates will prove correct risk losing time to adjust their energy consumption patterns if their optimistic expectations are not met." (ref. 10)

From the above data, one definite conclusion can be made: potential oil demand in the year 2015 is unlikely to be satisfied by crude oil production from conventional sources.

4.2.2.2. United States Petroleum

At present, the most serious problem confronting the U.S. is for the American public to realize the seriousness of the energy crisis. Since the energy address by President Carter in the spring of 1977, the public has been made aware of the problem. However, the President has not been able to mobilize public opinion quickly enough. The country has not reached a consensus on energy policy. Perhaps this is due to the way Americans tend to deal with an unexpected national problem (1) be skeptical of the problem's existence, (2) search for scapegoats, and (3) settle down to dealing with the problem. The previous section indicated that the world is rapidly approaching a petroleum supply problem. Is the United States? The 6 percent of the world's population that lives in the U.S. consumes 31 percent of the world energy production. Energy consumption in the U.S. has more than doubled in the past 25 years, from 34 quadrillion BTU's in 1950 to about 78 quadrillion BTU's in 1975. This increase is equivalent to an average per annum growth rate of 4 percent. Projections of the total energy demand (ref. 18) to 2000 vary considerably and range from 124 quadrillion BTU to 192 quadrillion BTU.

Forty-five percent of the U.S. energy demand is supplied by petroleum. Although Hendricks (ref. 19) has estimated that 400 billion barrels would be ultimately recovered, all other estimates are near 150 billion barrels. In a series of papers, Hubbert (refs. 20, 21, 22, and 36) "concluded that the amount of ultimately recoverable petroleum in the United States is between 150 billion barrels for the contiguous states and about 200 billion barrels for the entire continental United States (including Alaska and the outer continental shelves). Hubbert's method is one of integral logistic curve fitting. It is related only statistically to rocks and geologic parameters, and to those only



1--2 No OPEC Production Limit, assuming 20 BB/Yr. additions to reserves to 2000, declining to 4BB/Yr. by 2025

3--4 No OPEC Production Limit, assuming 10BB/Yr. additions to reserves to 2000, declining to 4BB/Yr. by 2025
3BB/Yr. by 2025

Figure 4.6 TWO OIL PRODUCTION PREDICTIONS (Source: Martin, 1977, p. 15, (Ref. 23).

through a variety of economic and technologic factors. Supposing that human beings will be doing in the future as they have in the past, so far as petroleum exploration is concerned both technologically and from an investment viewpoint, Hubbert's approach is unassailable." (ref. 15)

At the present time, about 100 billion barrels have been produced in the U.S. The U.S. has consumed between 25 and 40 percent of its own petroleum to this date. By the year 2015 between 80 and 90 percent will be consumed.

This decrease in availability of U.S. produced petroleum will have several effects: production will drop from 8 to 12 million barrels daily in 1985 to 6 to 10 million barrels daily in 2000 (ref. 10), the U.S. will become more and more an energy-deficient country, the possibility of restrictions and threatened restrictions on U.S. oil imports will increase, decrease the independence of U.S. foreign policy, and bring havoc to the complex of both international and domestic economic matters.

In 1960, the net rate of external dependence on foreign oil stood at 5 percent, in 1974 it was 16.3 percent, during the first half of 1978 it varied from 40 to 50 percent. The possibility that it could reach 70 percent by 1990 is very real. This would be equivalent to an annual deficit of some $50 billion in 1974 dollars.

It is the last figure which is the most important. Although the vulnerable nature of our energy dependence was made abundantly clear during the OPEC oil embargo, it is unlikely that the U.S. will be cut off from imported oil in the near future. But even if foreign imports are fairly assured for the near future, the balance-of-trade deficit is leading us into serious economic problems. We cannot long tolerate paying over $30 billion annually for imported oil that cost only $3 billion a year as recently as 1972.

In the next several years, the United States must develop a sound energy policy which includes the following parts: (1) rapidly increase the domestic energy supplies, (2) reduce demand by conserving energy, (3) develop new technologies through a massive new research and development program, and (4) aim for a lower energy future.

It would cost us little to direct the U.S. toward a low energy future and there would be major gains as to the possibility of ahcieving such an energy demand; a lowering of environmental and human damage, a lower risk of catastrophic accidents, and a strengthening of our economy.

4.2.2.3. Transportation -- Aviation

Primary energy consumption in the U.S. is almost evenly divided between residential, industrial, electrical, and the transportation sectors. Within the transportation sector, highway modes (bus, trucks, and autos) account for most of the energy consumed (Fig. 4.7.).

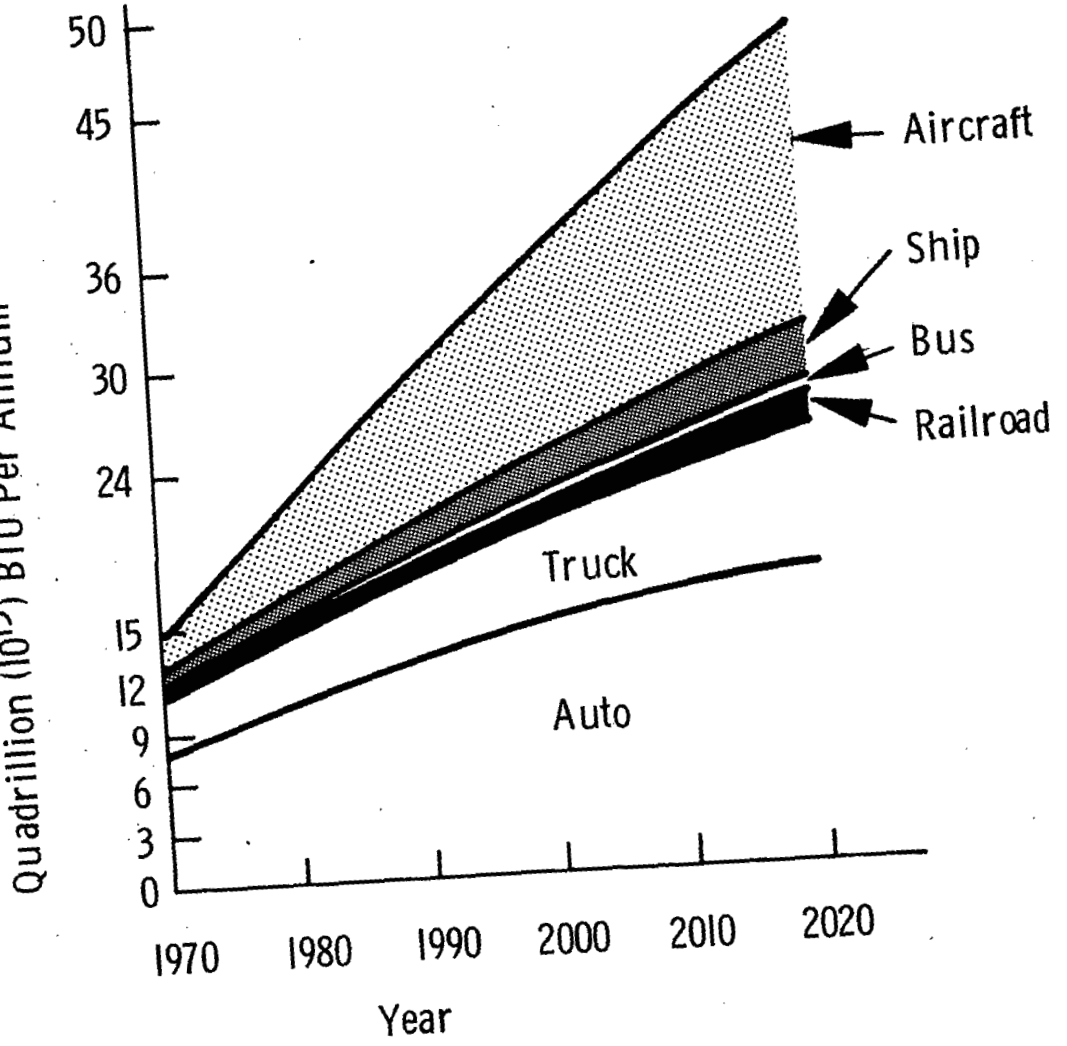


Figure 4.7 GENERALIZED ANNUAL TRANSPORTATION ENERGY CONSUMPTION Adapted from: Macrakis, 1974 (Ref. 37) (Sources: Duppee and West, 1972 (Ref. 38); Dyer, et. al., 1973 (Ref. 39(; Rice, 1970 (Ref. 40); Macrakis, 1974 (Ref. 37).

In the U.S., transportation accounts for about one-fourth of the total energy used and about half of the petroleum consumption. The energy consumed by aviation, which accounted for only a few percent of the transportation energy consumption in 1960, amounts to about 13 percent of the transportation energy usage (about 9 percent civil and 5 percent military) or less than 4 percent of the total U.S. energy consumption. Although air transportation accounts for a small fraction of the U.S. petroleum used, aviation in all forms (passenger, freight, general aviation, and military aviation) is 100 percent dependent on petroleum fuels and strongly influenced by the availability and cost of these fuels.

Aviation is growing at a faster rate than all other transportation modes with energy consumption having increased at a rate of about 11 percent per year between 1963 and 1973. Although there was a decrease in fuel use from 1974 to 1976 (6 percent), a continuing increase of 4 percent (Fig.4.5) for the air mode is very possible. If this growth rate continues to 2000, aviation will change from its present relatively modest role into the dominant factor in future transportation energy consumption. Projections of aviation growth vary from 2 to 6 times. But, whatever that growth rate in aviation, it will consume a much larger fraction of the transportation sector's fuel in the future (Fig. 4.7).

The growth in the all air-cargo fuel consumption is also expected to increase drastically in the future. At a 5.8 percent annual growth, it would increase from 680 million gallons in 1974 to between 6 and 7 billion gallons by 2015.

4.2.2.3.1. Aviation Fuel Problems

As the aviation fuel need increases and the amount of crude oil decreases, several problems will arise. One is the conflict which will occur between transportation sectors because of differing fuel-requirements. If pressure from either the motor gasoline, petrochemical or high quality gas/oil markets reduces the volume of jet fuel below demand, Jet B could substitute. However, increased demand for naphtha and motor gasolines could, as in the past, reduce Jet B's availability. There is also the possibility that a new need for the jet fuel fraction of crude oil could develop and cause aviation fuel shortages.

Another problem is the amount of direct operating cost (DOC) that is caused by fuel acquisition. The ratio of fuel costs to the total cost of air transportation has been relatively low for most of aviation's history. However, since the Middle East War of 1973 and its related embargo and fuel price increase, the price of fuel has become the single most important item in DOC.

It is this high fuel contribution to DOC that has brought about the situation whereby, at the current level of U.S. airline fuel use of 10×10^9 gals/yr (CAB data), each cent/gal increase in the price of fuel costs the airlines 100×10^6 dollars.

Of course, it is the increase in the price of fuel which is causing the DOC fuel problem. Air Transportation Association data indicate that the cost

of fuel climbed from $1.4 billion in 1973 to $2.3 billion in 1974 even though consumption was cut from 10.7 billion gallons to 9.6 billion gallons. Fuel prices will apparently continue to increase for the indeterminate future because of the inflationary spiral that has been generated. Fuel price increases join with other inflationary forces to drive up the prices of the things the oil-producing countries buy. This leads to further increases in what they charge for fuel. This increase will intensify as the necessity of exploiting new, more capital and energy-intensive fossil-fuel and raw materials sources increases.

This fuel cost problem will not be as serious for air cargo as for the passenger portion of aviation for if a ticket of a passenger increases from $300 to $400, there is certainly a chance of a decreased passenger demand. However, if the air-cargo rate goes from 30 cents a pound to 40 cents, the ten-cent increment can be readily passed on to the consumer as a 1 or 2 percent increase in the retail price of the goods. In summary from the energy point of view, aviation has to face in the short term much higher fuel costs with supplies critically dependent on political stability and in the long term steadily increasing fuel costs with no satisfactory alternative fuel yet in prospect.

4.2.3.3.2. Ways to Improve Fuel Utilization

The air transportation system, both in operation and equipment, has never been designed for minimum fuel utilization. Even so, the fuel efficiency of aircraft has improved from 1920 to 1975 by a factor of four. Using the value of 1920 as a constant base, this represents an average increase of about 5 percent per annum. From 1955 to 1975, the jet era, this rate of improvement has corresponded to a rate of 10 percent per annum. Now fuel efficiency is clearly the prime target for designers who, by technological advance, can directly influence the economic effectiveness of much of the research and development in the aerospace industry.

The rising energy consumption for all transportation, the increasing dependence of transportation on petroleum, the growing level of petroleum imports, the impending shortage of adequate oil supplies, and the rising price of fuel make the need for significant increases in aircraft fuel efficiencies mandatory. There must be no delay in developing advanced technologies to provide compensating improvements in fuel consumption. Sufficient research must be done to accommodate the use of alternative fuels should the need arise. While it may be hoped that economies in other energy areas will leave sufficient petroleum for the relatively small requirements of aviation, it is unacceptably risky to rely on such hopes. The airlines were the first, not the last, to have fuel allocations imposed in the fuel crisis of 1973-1974. A number of studies (refs. 24, 25, 26, and 27) have recently been made in response to the concern of the impact of the energy crisis on commercial aviation. These studies indicate that although current transport aircraft are reasonably energy-efficient, considerable improvements can be made in future aircraft designs through incorporation of advanced technology.

In addition to the technological advancements that can improve fuel efficiency, other direct and indirect energy requirements must be investigated. These other energy requirements include the energy expended in switching and repositioning equipment; regular maintenance; storage; training; extra operations because of adverse weather; equipment breakdowns; extraordinary traffic delays; heating, cooling, and lighting of offices and terminals; advertising displays; energy expended in producing, refining, and distributing the fuel; and the indirect energy consumed in constructing and manufacturing the various facilities, structures, and equipment associated with a particular transportation system.

Fuel efficiency improvements in some of the above areas were responsible for a 7.5 percent fuel consumption decrease during the 1973 to 1976 period even though the overall passengers carried increased by 10.4 percent.

A listing of possible methods to increase fuel efficiency appears below. It is divided into management and maintenance, aircraft technology, and operational procedures (aircraft flight operations and aircraft ground handling).

Methods to Increase Fuel Efficiency

I. Management and Maintenance

Retirement of older inefficient airplanes
Drag reduction maintenance
Reduced training flights (use of simulators)
Increased seating and payloads
Rely on energy-economical concepts where possible (ex: lighter-than-air heavy cargo lifting)
Higher density seating (increased capacity)
Higher load factors
Fleet mix and usage
Airport design

II. Aircraft Technology

Advanced airfoil design - new supercritical wing, improved aerodynamic fairings
Increased aspect ratio - stretched fuselage
Lowered structural weight by less swept, thicker wing
Use of composite materials - fairings, wing and tail extensions, floor, doors
Fuel conservative engines (optimum design parameters between engine specific fuel consumption and aircraft design efficiency parameter)
Active controls to reduce size, weight, and drag of surfaces
Laminar flow by boundary layer control
Re-introduction of turbofan where possible
Alternative fuels utilization and the engines that can use them (this would act to decrease dependency on petroleum-derived fuels)
Wing tip vortex dissipation

III. Operational Procedures

A. Aircraft Flight Operations
- Climb to cruise altitude as fast as possible
- Select fuel efficient cruise altitude
- Use fuel efficient speed enroute
- Hold to cruise altitude as long as possible
- Use fuel efficient descent profile and if possible idle some engines
- Use minimum circuitry in departure and approach patterns
- Reduced air traffic control delays
- Routine monitoring of flight fuel consumptions and operating procedures
- All weather operations

B. Aircraft Ground Handling
- Reduce engine usage in taxiing in
- Take delays at gate with engines off
- Delay start up of engines until pushoff
- Reduce engine operation in taxiing out
- Increase use of towing
- Manage better all the terminal operations
- Better diagnostic procedures of engine problems and use of materials that resist deterioration
- Control of fuel reserves and dumping

The above information was compiled from sources in references 25, 27, 28, 29, 50 and 51.

Once the operational and management improvements are implemented, the reduction of aircraft fuel consumption will occur by employing advanced technology to improve the efficiency of the vehicle and the propulsion systems. Figure 4.8 illustrates some of these improvements interrelated to the percent of fuel utilization improvement and the years of introduction. When advanced engine and materials as well as the laminar flow control are available, the possibility of a completely new fuel efficient plane will increase. This may also be when alternative fuels will become the major source of aircraft fuels.

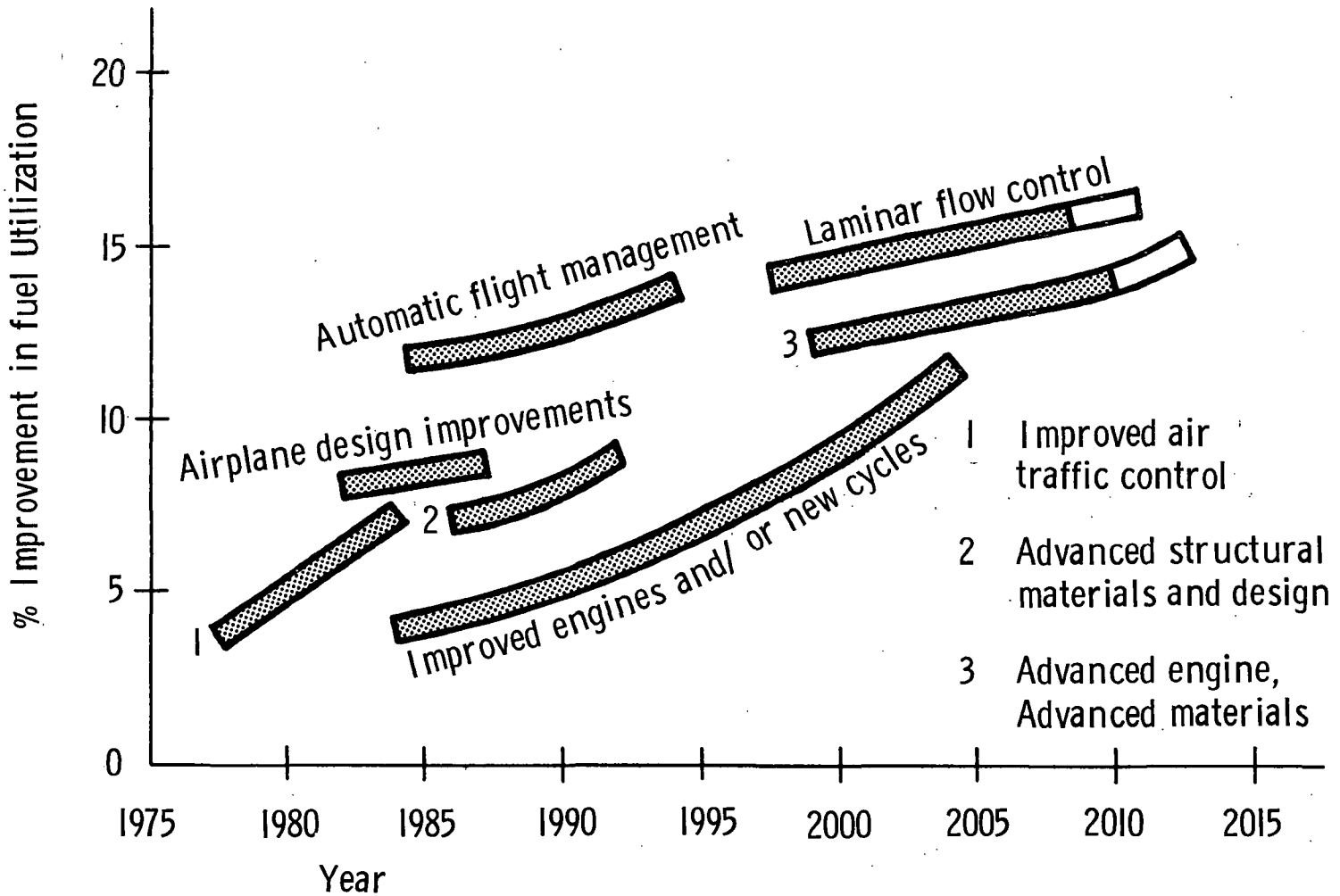


Figure 4.8 THE PERCENT OF FUEL UTILIZATION IMPROVEMENT RELATED TO THE YEARS OF INTRODUCTION

4.3 PUBLIC POLICY, ACIS AND FUELS

There are three special areas where public policy makers should direct their attention with respect to the ACIS. These areas are: (1) the design of a fuel efficient intermediate size aircraft; (2) allocation of fuel to ACIS in the event of a critical fuel shortage; and (3) the development of alternative fuels.

4.3.1. Fuel Efficient Aircraft

A fuel efficient intermediate size aircraft is needed. This plane should be designed to accept standard size containers, use composites wherever possible, and have a fuel efficient engine; possibly a new type of turboprop which is highly loaded, multibladed, and has advanced blade structure.

The above described aircraft is needed now, but because of the serious economic problems of all segments of the U.S. including the airline and aircraft industries, it is not presently being given the attention required for implementation. In the very near future, 1980-1985, this attitude must change. ". . . there should certainly be a heightened emphasis on research and development work related to future potential aircraft systems, with emphasis on improved efficiency at reduced cost. Whether derivatives or new systems prevail, only through aggressive and dedicated research and development efforts can the many potential improvements in fuel conservation, other operational cost factors, and production costs be brought to fruition. All of the technological potentials discussed earlier, and many more, need to be developed further. It is through this entire mechanism, of course, that one should reasonably expect to discover one or more "breakthroughs," which will be the means of a shift from our current technology curve to another more beneficial level, thus alleviating the adverse cost impact factors now faced by all new cargo systems. When one reflects that it has been only a little over 20 years since the first service of a British commercial jet-propelled passenger airplane and less than 17 years since the first commercial service of a U.S. jet, the supposition that a few more years might have to pass before a significant breakthrough may be made with new advanced cargo aircraft should cause no great disappointment." (ref. 30)

4.3.2. Fuel Allocation in Case of Shortage

The OPEC oil embargo of 1973 drove home the dependence of the U.S. economy on imported petroleum. As has been previously presented, this dependence has increased since 1973. At the time of the embargo, the federal government limited sales of automobile gasolines; however, the only public mode of transportation to be allocated reduced fuel supplies was the commercial airlines. Why was this done? The scheduled domestic airlines consumed less than 5 percent of refinery output and it is very likely that the traffic shifts from automobiles increased the public demand for air service. If the same situation

happened now would the same result occur? Very likely. Jet aircraft are very visible consumers of energy and their "high" fuel consumption is the subject of much discussion.

If the ACIS is allowed to come into being, policy planners must safeguard against any shortsighted response which could be far more destructive for a highly integrated air cargo system than would be the case for passenger systems. In the first place, our system is characterized by low connectivity; a drastic cutback in fuel might, therefore, render the system totally inoperative. In the second place, we recommend vertical integration of cargo carrying modes. Thus, a disruption of one element of the system might render a much larger system inoperative. In the third place, the kinds of saving we expect shippers to realize, when using air rather than truck, depend largely upon their being able to lower inventories. Thus the users of air cargo will become extremely vulnerable to any stoppage in the movement of their goods. It is probably impossible to even begin to calculate the amounts and kinds of economic damage that might occur if, after allowing the ACIS to be put into place, we then permit the capricious disruption of the system. For, although it is true that only a small part of all goods shipped will move by air, those goods that are shipped by the ACIS will be essential to the utilization of things moved by other modes. Therefore, whole industries might fail to function if ACIS fails to function.

As has been mentioned before, the air transportation demand for fuel has grown from a few percent of all transportation energy consumed in 1960 to about 13 percent today. Of course, this growth calls attention to aviation's demands on a petroleum supply which is being depleted; however, air transport has demonstrated a continued history of improved energy efficiency. To give perspective, when the 1976 demand for major petroleum products is compared with the 1970 demand, the airlines have stabilized but other petroleum product consumers have demanded large increases: 19.5 percent for motor gasoline, 23.2 percent for distillates, and 26.4 percent for residual fuel oil. These "increases are the major cause of the continued rise in the nation's petroleum consumption and a cause of the accelerating import problem. Indeed, the increase in gasoline consumption from 1970 to 1976 exceeds the total jet fuel consumed by all aviation in 1976." (ref. 31)

There are two other major factors which strengthens the airlines case for the right to fuel: (1) The increased opportunity and productivity of passengers because of the speed of aircraft which also allows a greater radius of communication and travel. This benefits the nations economy. (2) A healthy airline industry assists the foreign trade balance of payments. Exports of commercial air transports and associated equipment generate approximately $3 billion each year. Airline competition has fostered a manufacturing industry whose products dominate world air transportation.

We believe that from a cost/benefit viewpoint, aviation is vital to our nation. Aviation provides vital services and capabilities that cannot be achieved in any other way. Aviation is not grossly consumptive of energy and airplanes of the future will be able to compete very favorably with other forms of transportation on an energy basis. "Adequate air transportation

today is not merely a convenience but a vital resource that cannot be given up without major changes in lifestyles, business procedures and productivity in government, industry, and private affairs" (ref. 25) The airlines provide a service that is not duplicated by the other transportation modes. In future restricted import situations, federal policy should be founded on a well researched understanding of the needs and alternatives for all users rather than a reactive solution based on the strength of political lobbies.

4.3.3. Alternative Fuels

Even if the aircraft industry is exceptionally successful in succeeding to develop and implement all the fuel efficient programs listed previously. They may still experience long-term difficulties in meeting jet fuel requirements from domestic and imported petroleum supplies. Not only is there an increasing demand for the crude oil fraction that can be made into jet fuel, there is a definite limit to the crude oil supply.

Therefore, it is assumed that in the early twenty-first century some supplementary alternative fuels will be developed. A tremendous amount of effort has been expended on trying to determine the actual alternative fuel to be developed (refs. 17, 27, 32, 33, and 4). Because they must be readily available, at a realistic price, compatible with existing aircraft and ground facilities, and not disturb operational or other characteristics of the aircraft used, it is believed they will be much like those in use today and will be produced by utilizing coal and possibly oil shale as the basic source (refs. 35, 36, 37, and 38). There is also a chance that more unusual fuels, such as methanol, methane, hydrogen, and even nuclear, may be used (refs. 39, 40, 41, 42, 43, and 44).

4.4 GOVERNMENT ROLE AND MARKET FORCES

4.4.1. The Role of Transportation in the U.S. Economy

Because of the vital role of transportation in the life of the nation, federal, state, and local governments have, in the past, participated in its promotion, planning, and support. The U.S. has provided subsidies and aids to various transportation modes in promoting commerce, the Postal Service, national defense, and international trade. Transportation even in a capitalist or market system, such as the U.S. is rarely left completely to the market. Accordingly, it has been a mixed system of private and public enterprise.

The federal government has played a very important role in the development of air transport. For example, from 1919 to 1923, the Post Office Department experimented with mail transportation. After 1925, the Department of Commerce took over the task of developing a system of civil airways and aids to navigation. The federal government has also provided and operated the airways, air navigation facilities, and air traffic control through the Federal Aviation Administration. Local governments have also been involved in the development, operation, and support of airports.

The promotion of the ACIS is also an important factor in employment. According to the U.S. Department of Labor, transportation's share in total national employment will drop from 4.5 percent in 1968 to 2.8 percent by 1985, but the proportion of civil aviation workers in the transportation labor field should increase from 14 percent in 1968 to 28 percent by 1985 (ref. 45). An ACIS could also beneficially affect gross national product and tax receipts.

4.4.2. Improvement of the Balance of Trade

The aerospace industry also plays a very important role in the U.S. balance of trade. In 1977, while the U.S. suffered a trade balance deficit of $29.113 billion, the aerospace industry had a trade balance surplus of $6.850 billion. Aerospace industry exported $7.581 billion and imported only $731 million. Aerospace industry was second only to agriculture in favorable contribution to our balance of trade. Since World War II, the aerospace industry has contributed a great deal to the U.S. balance of trade (Table 4.8).

4.4.3. Government Role in the International Market Place

Before and during World War II, the U.S. conducted an aeronautical research and development program of extraordinary scale. In the post-war decade, U.S. aircraft builders further benefited from new technology made available by advancing research and development. Thus, the U.S. has continued its superiority in the aircraft industry, but whether we can maintain our superiority in the future is of great concern to many persons in this country.

Table 4.8

TOTAL AND AEROSPACE BALANCE OF TRADE
(Millions of Dollars)

Year	TOTAL U.S. Trade Balance	Aerospace			Aerospace Trade Balance as Percent of U.S. Total
		Trade Balance	Exports	Imports	
1960	$ 5,369	$ 1,665	$ 1,726	$ 61	31.0%
1961	6,096	1,501	1,653	152	24.6
1962	4,180	1,795	1,923	128	42.9
1963	6,061	1,532	1,627	95	25.3
1964	7,555	1,518	1,606	90	20.1
1965	5,875	1,459	1,618	159	24,8
1966	4,524	1,370	1,673	303	30.3
1967	4,409	1,961	2,248	287	44.5
1968	1,133	2,661	2,994	333	234.9
1969	1,599	2,831	3,138	307	177.0
1970	2,834	3,097	3,405	308	109.3
1971	-2,024	3,830	4,203	373	
1972	-6,351	3,230	3,795	565	
1973	1,222	4,360	5,142	782	356.8
1974	-2,996	6,350	7,095	745	
1975	9,625	7,045	7,792	747	73.2
1976	-7,803	7,267	7,843	576	
1977	-29,113	6,850	7,581	731	

Since the 1960's due to the Vietnam War, high rates of inflation and a general decline in national economic health, federally funded research and development in the United States has declined. In the meantime, the governments of Western Europe and Japan have provided strong financial support to their aircraft industry in the area of research and development. The growth rate in aerospace research and development for the Common Market countries has averaged 15 percent annually, compared with 6 percent for the United States.

European governments are promoting the consortium approach to aircraft development. For examples of such collaborative efforts, see Table 4.9. Cooperation among nations makes it possible to undertake programs that would otherwise be impossible for an individual country. The consortium approach makes it possible to utilize economic resources of the cooperating nations in the most efficient way for research, development, testing, and production. It also allows nations to take advantage of economics of scale in production because of internal market size. The Western European countries, taken together now constitute a market equal to that of the United Stated. A cooperative approach fosters development of a wider range of aircraft types because of the broader market and differing kinds of service provided by the airlines of the cooperating nations (ref.42). Thus the consortium approach provides a potentially strong competitive challenge to American industry.

In order to improve the state of the aircraft manufacturing industy and to compete with foreign countries, it is essential for this country to have healthy airlines. A study of the ownership of airlines reveals that all major foreign international airlines except CP Air are wholly or partially owned by their governments (Table 4.9). Foreign governments are also involved in the operations of the airlines and this enables foreign airlines to capture a greater share of the international market. NASA Cargo/Logistics Airlift System Study (CLASS) completed in June 1978 by the McDonnell-Douglas Corporation predicted that market growth between 1978-1990 for U.S. international airlines will increase by 8.3% annually whereas foreign airlines will increase by 14.3%.

In the face of increased European national and multinational financial involvement in the development of advanced technology, the production of aircraft, and the operations of airlines, it is essential for the U.S. government, not only to be involved in the development of the advanced air cargo system, but also in the development of future cargo aircraft.

4.4.4. Capital Formation and Government Role

According to the Air Transport Association of America, the airlines will need about $60 billion for the ten year period, 1980-1990 (ref. 47). Industry leaders and stockbrokers feel this amount can be raised in the absence of deregulation, with only minor difficulties experienced by a few carriers. The capital requirements after 1990 will depend upon the needs of new aircraft and the investment in ground support. Because the investment in ground support, such as terminals and equipment, is approximately 10 percent of the cost of the planes, the major capital requirements for the near future will be for aircraft. The airlines and aircraft manufacturers are the principal portion

of the aircraft industry that require capital.

4.4.4.1. Carrier

There are five principal sources of funds for transportation carriers: debt financing, equity financing, retained earnings, the government and manufacturers.

Historically the air transport industry has had a high level of financial leverage; a high debt-equity ratio. This is because of the heavy reliance on debt instruments to finance aircraft and equipment. Such financing occurs because the cost of debt financing is low relative to equity financing. In the early 1970s, debt-equity ratios peaked at 2:1 for the carriers as a group, and individually some crossed the line of 3:1. Because of regulation, lower levels of competitive risk and the assured nature of carrier route structures and fare levels, the air transport industry was able to support a high level of financial leverage. However, in a non-regulated market, financial institutions and investors will want to see the debt-equity ratio at a 1:1 ratio; so, carriers will have to undertake a combination of debt reduction and new equity financing. Deregulation and the new attitude of the CAB, which indicates it now will tolerate some carrier financial failure, at least for the short run, will cause financial institutions and investors to be reluctant to lend capital to already heavily-indebted airlines. However, some carriers, Delta and Northwest Orient for example, will still be able to borrow without much difficulty. Northwest's debt is small by trunk airline standards, and Delta, although it has gone deeper into debt, has nonetheless stayed below a 1:1 debt-equity ratio.

In the long run, economic deregulation will create a climate in which the industry will prosper, even though some specific carriers may not. A general increase in supply and capacity of the domestic air cargo industry can also be expected because of deregulation. The market will tend to create more premium services at higher prices in heavy traffic markets. The market forces will also permit the emergence of intermodal transportation companies. This means that some carriers will emerge as financially sound companies and will be able to generate enough capital through retained earnings and equity financing to purchase new aircraft. The successful sale of equity depends on investor confidence. If deregulation would make the air transport industry a growth industry again, carriers would be able to raise capital without too much difficulty.

4.4.4.2. Manufacturer

Developing a new aircraft calls for an enormous investment by the manufacturer. Costs have risen to the point where it takes more than one billion dollars to design and build an operational airplane. Figure 4.9 presents the financial history of the development program for a hypothetical new technology subsonic jet transport. In the first four years of development, the program would not reach the break-even point for about eight years or until after about 330 aircraft have been delivered (Fig. 4.9).

Table 4.9

GOVERNMENT OWNERSHIP:
24 FOREIGN AIRLINES, PAN AM AND TWA

Airline	Ownership
Aerlinte Eireann (Irish)	100 percent government owned.
Aeromexico	100 percent government owned since 1959 through Nacional Financiera S.A.
Air Canada	100 percent government owned through Canadian National Ry.
Air France	98.55 percent government owned.
Air India	100 percent government owned.
Air New Zealand	100 percent government owned.
Alitalia	75.5 percent government owned thru Instituto per la Reconstruzione industriale (IRI).
Argentine Airlines	100 percent government owned.
Aylanca	Substantially owned and effectively controlled by Colombian government Pan Am owns 14 percent but exercises no management control.
British Airways	100 percent government owned.
CP Air	Privately owned by Canadian Pacific Ltd.
Et al	Government owned except for a few shares.
Iberia	Wholly government owned except for few shares, thru Instituto Nacional de Industira (INI).
Iran Air	100 government owned.
Japan Air Lines	45 percent government owned. Government effectively controls airline.

Airline	Ownership
KLM	70 percent government owned; government effectively controls KLM.
Lufthansa	Government and government institutions own 70.15 percent.
Pan Am	Privately owned.
Philippine Air	75 percent privately owned; quasi-government insurance corp. owns 25 percent.
Quantas	100 percent government owned.
Sabena	65 percent government owned; rest by individuals or in trust by government.
SAS	55 percent owned by governments of Denmark, Norway, Sweden; 45 percent by private investors.
Swissair	Government units and institutions own 23.6 percent
TWA	Privately owned.
Varig	96.11 percent privately owned, 3.89 percent by state government.
Viasa	Government of Venezuela holds 55 percent domestic airline Avensa owns rest.

Source: Aviation Economics, Joint Hearings Before the Subcommittee on Investigations and Review and the Subcommittee on Aviation on the Committee on Public Works and Transportation, House of Representatives 94th Congress March-April, 1976, Washington: U.S. Government Printing Office, pp. 24-31.

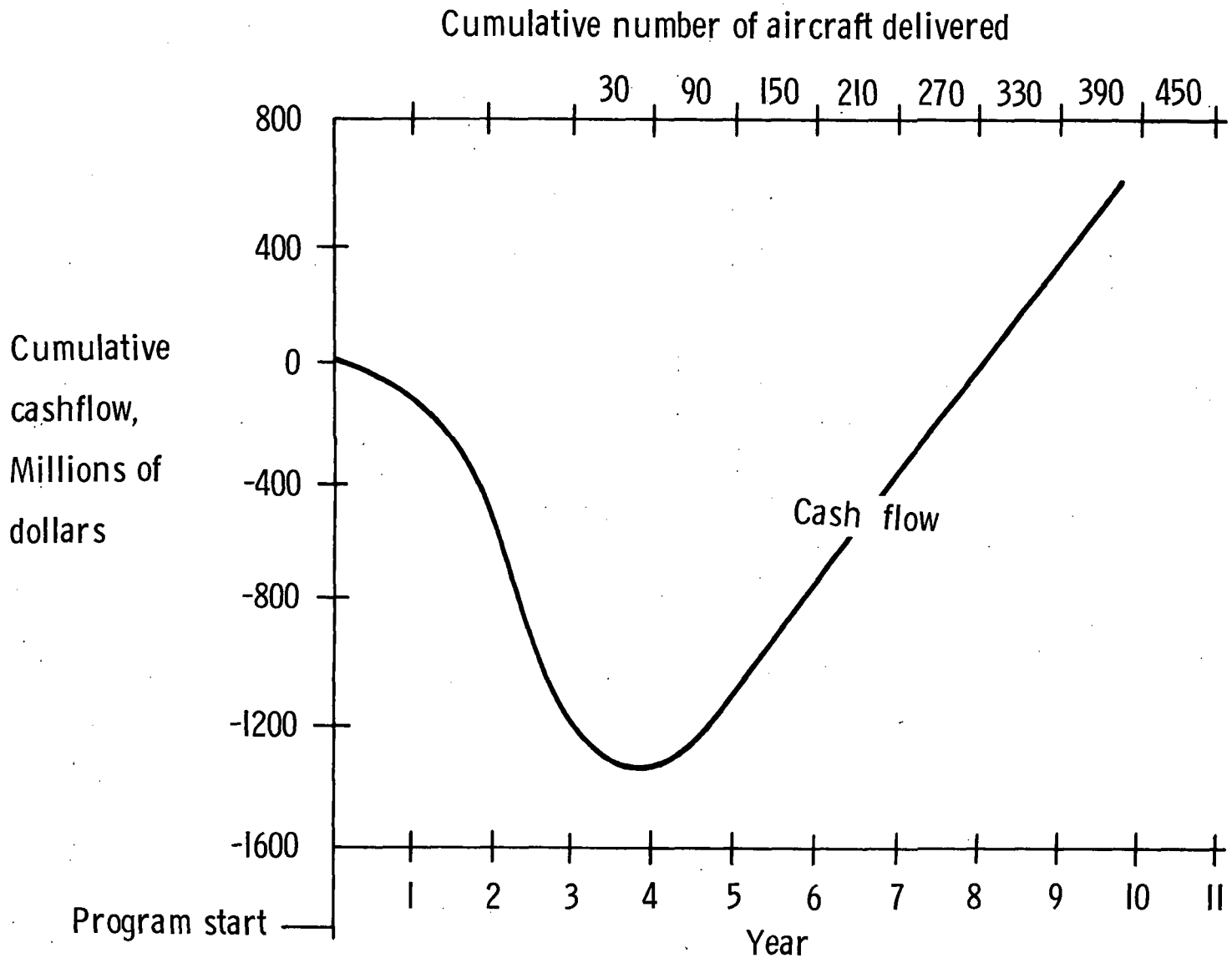


Figure 4.9 CASH REQUIREMENTS; LARGE COMMERCIAL AIRCRAFT PROGRAMS PRIVATE FINANCING (Source: MIT-NASA Workshop Airline Systems Analysis, Volume 2, July 1972, p. x-16).

The aircraft manufacturing industry has been and always will be dependent upon government for research and development. However, in the past, the American manufacturers have been able to finance their own commercial aircraft programs. It can be assumed that they will be able to continue to do so in the future. The financial positions of the manufacturers will allow them to undertake development of new commercial aircraft programs if the demands of a new aircraft justify the investment. Table 4.10 shows that the long-term debt for Boeing is comparatively limited and the company will be able to go to the market for borrowing. Boeing also has an unused line of credit. There will be other sources of money available to the company as well. McDonnell-Douglas has limited its long-term debt. The need for a U.S. Government guarantee has now been eliminated for Lockheed because of the improvement of its financial position. Boeing has managed to retain equity well in excess of issued stock value. McDonnell-Douglas has a smaller stock base, but its stockholders' equity is close to the Boeing figure. Lockheed, of course, needs much strengthening in its equity (Table 4.10).

Table 4.10 shows that the net profit after taxes, as a percent of sales for aerospace manufacturing corporations, has improved since the 1960s. If the demands of a new aircraft justify the investment, the capital can be provided by air transport carriers and manufacturers.

4.4.4.3. Government

In buying aircraft, the financial arrangement is a dominant factor. Foreign governments and foreign manufacturers are very much involved in the financial arrangements related to the sales of their airplanes. For example, Airbus Industrie came up with guaranteed financing for its $778 million package sale to Eastern and Rolls-Royce Ltd., a British state-owned engine maker, offered to guarantee financing for Pan American World Airways to purchase airplanes equipped with Rolls Royce engines. Foreign manufacturers will have an obvious advantage over American manufacturers because the latter cannot offer guaranteed financing. By working with American manufacturers, the United States government can get involved in guaranteed financing to purchase American aircraft and help to offset the support that foreign industries are getting from their governments. This support is needed if the positive trade balance of the aerospace industry is to continue.

4.4.5. Conclusion

In the face of increased European consortium, nationalism, foreign government financial involvement in the development of advanced technology and production of aircrafts, and operations of airlines, it is essential for the U.S. government, not only to be involved in the development of the advanced air cargo system, but also in the development of future cargo aircraft. By 1980, the U.S. government should be involved in guaranteed financing to purchase aircraft in order to enable U.S. industries to compete effectively in world markets, and to maintain their superiority in air transport and aerospace industry. While the general philosophy of the United States has been to idealize competition in our domestic economy, we must reexamine the concept of "competition" in the light of foreign government involvement in international economy and global politics in 1990.

Table 4.10

U.S. AIRCRAFT MANUFACTURING COMPANY BALANCE SHEETS
(millions of dollars)

	Boeing		Lockheed		McDonnell Douglas	
Fixed assets		400.7		256.1		249.6
Current assets	1,771.0		848.9		2,018.3	
Current liabilities	1,029.9		780.5		1,332.2	
Net current assets		741.1		68.4		686.1
Other assets		268.7		463.9		199.6
Capital employed		1,410.5		788.4		1,135.3
Long-term debt		104.1		536.0		79.5
Other liabilities		75.1		33.6		--
Net worth		1,231.3		218.8		1,055.8
Preferred stock		-		48.5		
Common Stock		553.9		11.4		38.4
Share premium		-		88.4		314.1
Retained earnings		684.0		70.5		721.1
Treasury stock		(6.6)		-		(17.8)
Shareholders equity		1,231.3		218.8		1,055.8
1977 SALES						
Aircraft		3,423		1,970		2,841
Spares and missiles		446		1,206		601
Other		208		197		163
Corporate income		47		-		-
TOTAL		4,124		3,373		3,605

Source: Flight International, June 10, 1978.

4.5 MILITARY AIR CARGO NEEDS AND DEFENSE POLICY

As American forces pull back from Europe and Asia, the demand on our strategic airlift capability increases. An advanced air cargo system is important to our national defense. Not only does the system serve the needs of our complex economy but at the same time it provides the military with a ready capability through CRAF (Civil Reserve Air Fleet) to meet our strategic needs. The post-Vietnam political environment has generated a number of perceptible trends in American society that are relevant here.

The critics of military spending have argued that the expansion of military budgets results in lower level of public expenditure on the development of social programs (ref. 49). As Figure 4.10 shows, the world's arms budget was almost double the public expenditure for health care in 1975. Such analyses have generally contributed to critical orientations toward military spending (ref.50).

In Western Europe, the younger generation has developed a negative attitude toward military expenditure. In the words of a member of the Western European elites, "There is growing up a generation which, mercifully, has had no firsthand experience of war and all that it means in terms of human misery and national disaster. This generation is now reaching the age where its members are becoming influential in politics, commerce, industry, and all aspects of life. It is therefore expected that its attitude toward defense expenditure, and indeed to military strategy, will be very different from those of the preceeding generation, which has experienced two disastrous European wars (ref. 51).

In the United States, there are various sentiments toward the need to reduce military expenditures. At the height of the Vietnam war, as many as 52% of a national sample wanted to see reduction in military spending. These sentiments have recently waned and in 1977 the figure dropped to 23%.

Nevertheless, the American public does not seem highly supportive of overseas military involvement (ref. 52). As Table 4.11 shows, only a minority of the American public would recommend sending troops to foreign countries. There is significant variation, however, in this dimension of public opinion. Sending troops is recommended by 57% of the public if Canada is attacked, however it drops to 7% in the case of India and Saudi Arabia.

In recent years, the American military has been the subject of critical journalistic and scholarly writings (ref. 53). The military is perceived as just another interest group trying to get a slice of the budget pie (Fig. 4.11). Buzz phrases such as "military industrial complex" and "interservices rivalry" are expressions of critical attitudes toward military projects and its R & D requirements (ref. 54, 56). Arguments have been made in favor of more detailed scrutiny of military budgets by the Congress. However, growing awareness of the nature of government decision-making processes may have contributed to

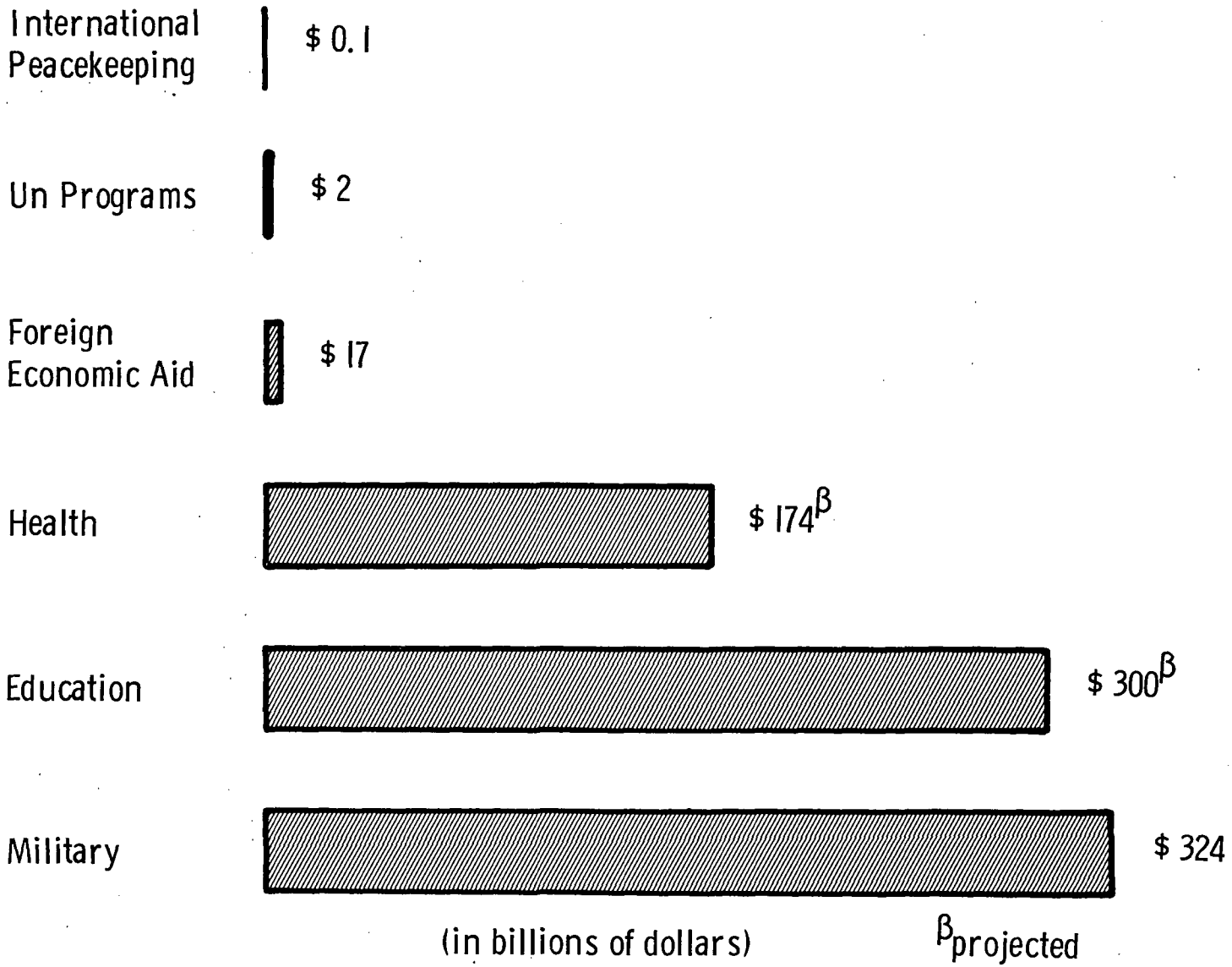


Figure 4.10: COMPARISON OF WORLD EXPENDITURES, 1975 (Source: Military Budgets and Social Needs: Setting World Priorities (New York: Public Arrairs Committee, 1977, p. 4).

Table 4.11

ORIENTATIONS OF AMERICAN PUBLIC TOWARD
U.S. MILITARY ASSISTANCE TO OTHER NATIONS*
(1975)

Selected Nations	Typologies of Public Response			
	Send Troops	Send Supplies	Do Not Involve	No Response
England	37%	30%	24%	9%
West Germany	27%	32%	33%	8%
Canada	57%	19%	14%	10%
Israel	12%	42%	37%	9%
Japan	16%	35%	40%	9%
Mexico	45%	26%	19%	10%
Brazil	16%	36%	33%	15%
Taiwan	8%	27%	54%	11%
Turkey	10%	36%	37%	17%
India	7%	40%	39%	14%
Philippines	29%	34%	26%	11%
Saudi	7%	27%	54%	12%

Source: Gallup Abstract, July, 1975.

* Percentage of national sample suggesting different types of military involvement overseas.

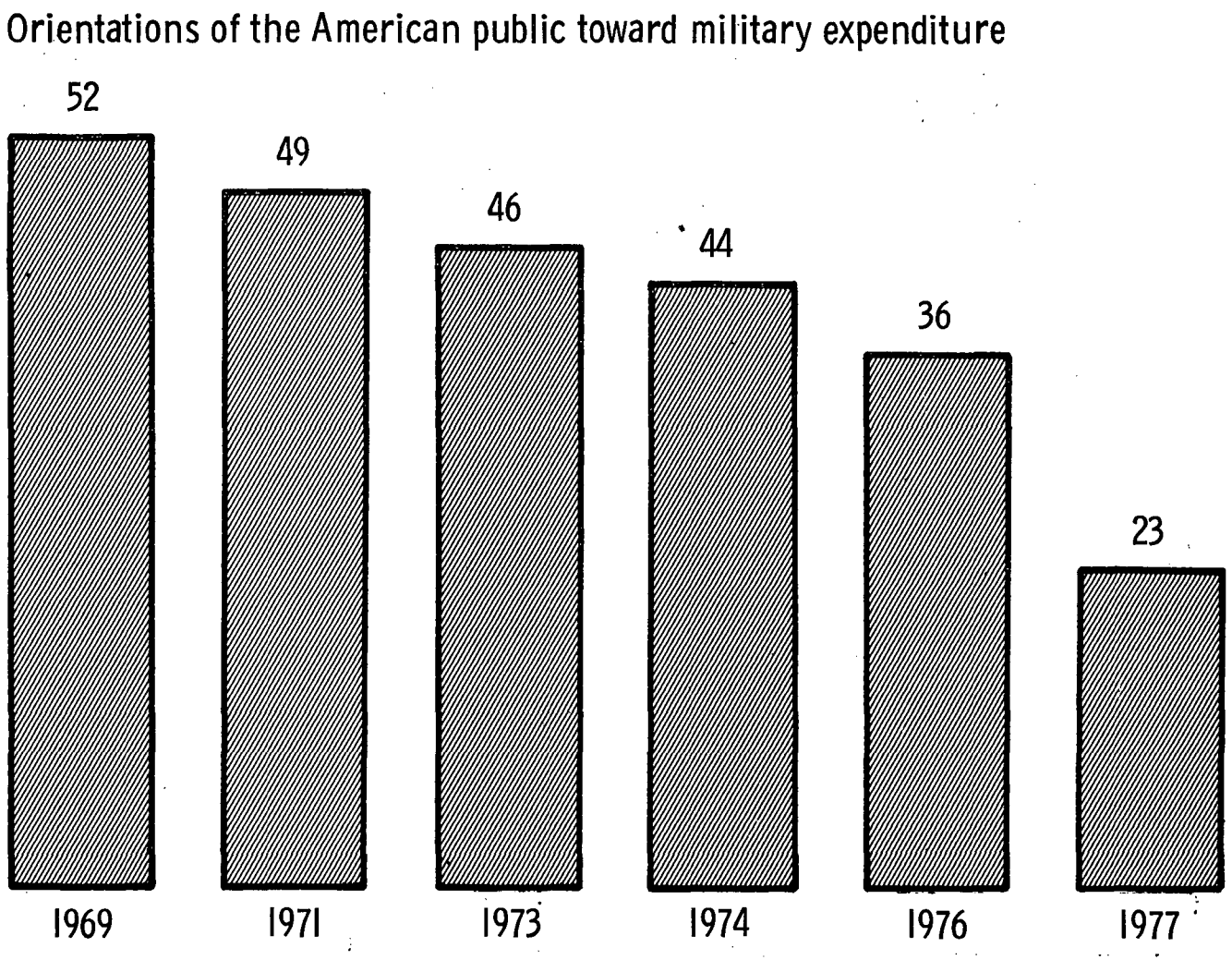


Figure 4.11 PERCENTAGE OF NATIONAL POPULATION OBJECTING TO EXCESSIVE MILITARY SPENDING (Source: Gallup Abstract).

these views. In recent years, there has also appeared in print increasing criticism of government agencies in general, as well as those specifically directed against the military. These developments may have influenced the degree of public support of governmental institutions.

The air cargo needs of the American military are directly related to its mission to move troops and material rapidly wherever they may be needed to counter threats against "U.S. interests". The concept of U.S. interests is a rather broad one seldom clearly defined. What sort of situation may be conceived as a threat to U.S. interests? To which parts of the world will the American military be called upon to move troops and material to protect such interests? These are situations questions that directly relate to this concept (ref. 57).

In the budgetary proposal for the Fiscal Year 1979, the Carter administration has explained the goals of the American military as follows:

> Protect America's people, its institutions, and its lands from aggression.
>
> Preserve an overall military balance between the United States and its allies, and the Soviet Union and its allies, that is at least as favorable as the present balance.
>
> Maintain essential equivalence in strategic nuclear deterence with the Soviet Union, preserving the capability to launch a retaliatory second strike that would inflict unacceptable damage.
>
> Maintain sufficient power, together with our allies, to defeat any aggressors swiftly, with full recovery of any territory lost initially.
>
> Seek international agreements to limit and reduce all armaments, to prevent proliferation of nuclear technology, to restrict arms trade, to settle disputes by peaceful means, and to strengthen international stability.

A broad interpretation of these defense goals might involve the mobilization of American Armed Forces and their dispatch virtually anywhere in the world. What will defense needs mean in terms of these goals in the year 1990 and thereafter? The post-Vietnam era has introduced some realistic changes in the goals of the American Armed Forces. At present, the American military perceives its international role in terms of the protection of NATO members. In the absence of any significant political change in the individual countries of Europe, it is most likely that the American commitment toward NATO will continue.

Now, we may proceed to analyze the air cargo needs of the American military as indicated in the documentary material (ref. 59). The Department of Defense desires the following air cargo capability for the immediate future.

Military Air Cargo Needs of the Future

General: Capability to Airlift 370 000 tons to Europe in 30 days

Cargo: 93 000 tons outsize - 230 000 tons oversize - 47 000 tons bulk

In a position paper prepared in March 1978, the Military Airlift Command (MAC) outlined their concept of the military C-XX; a large cargo transport aircraft that would meet their future transportation needs. A significant aspect of their proposal is that the C-XX be an all-cargo advanced aircraft that will meet both civil and military needs. These aircraft would be owned and operated by the airlines for their civilian cargo services, but in case of national emergencies, the military would acquire them for supporting their overseas mission. The military projects a total buy of 60 C-XX aircraft between 1990 and 1996 out of a total U.S. buy of 300.

This summarizes the military advanced air cargo needs as projected by the military position, but an evaluation of such needs is extremely difficult for a variety of reasons. In an earlier evaluation, the GAO criticized the specific project of airlifting 370 000 tons of cargo the Europe (ref. 59). The GAO criticisms were directed at a non-availability of airfields in Europe, refueling problems, and expense of the airlift operation. These criticisms are largely applicable in the case of C-XX proposal.

Since a major thrust in the military proposal for the advanced air cargo aircraft involves the defense of the NATO nations, it seems pertinent to examine this aspect in the context of the European nations.

In a meeting of the NATO leaders held in Paris on February 17, 1977, under the auspices of the Atlantic Institute, the issue of new large transport aircraft was discussed. A member of our research team interviewed an observer of this meeting in Paris (ref. 60). This interview data and a review of the proceedings of the meeting led us to infer that the leaders of the European nations present came to the following conclusions:

a. There will be a continuing and increasing need for strategic air transport for deterence, mobilization, and resupply of NATO forces in Europe.

b. International cooperation may be essential for the development of a new large air transport aircraft.

c. Such cooperative approach would be a way to achieve weapons system standardization desired by the NATO participants.

d. A major European delegate at this meeting suggested specific plans for a joint European-U.S. effort to produce a large cargo aircraft.

The nations of Western Europe face a continuing dilemma in respect to their relationships with the United States. Most of the nations of Western Europe perceive the need for U.S. presence, but they are extremely sensitive about the dominant position of the U.S. aerospace industry (ref. 61). They openly discuss the need to revive the European aerospace industry and achieve access to protected American markets. These concerns have led European nations to undertake projects like the Anglo-French Concorde and other collaborative arrangements to produce aircraft (ref. 62) (Table 4.12).

A content analysis of the proceeding of the Symposium of European Armament Policy held in Paris (3rd-4th March, 1977) provides some clues to understanding their motivation (Table 4.13).

This analysis suggests the following inferences about the air cargo needs of the American military and the options associated with such needs.

(1) First, it is clear that in the face of world-wide budgetary pressures (including the U.S.A.), the air cargo needs of the U.S. military may have to look toward the "concept of sharing".

(2) Second, since the air cargo needs of the American military are directly related to contingency plans for European defense, European collaboration deserves detailed study. There is adequate evidence to suggest that European nations want collaboration in at least one area of advanced cargo aircraft production.

4.5.1. European - U.S. Collaboration

The preceding discussion has been analyzed exclusively from the point of view of the United States. Collaboration in aircraft production can also be analyzed from the world point of view.

It seems all nations of Western Europe are concerned about cuts in their defense budgets. Some are specifically concerned about the lack of support for the military among the younger generation. They do not perceive a supportive attitude toward military expenditure among those members of their populations that have not experienced war. Collaboration in meeting defense needs could, ease pressure on their defense budgets. Collaborative production of a C-XX type advanced cargo aircraft is one attractive option for the United States, but as discussed earlier in this chapter, institutional constraints impede its realization. There are many dimensions of collaborative aerospace enterprise and therefore an European-U.S. collaborative venture raises many interesting questions. What shall be the nature of aerospace enterprise? How will the American aerospace industries participate in such organization? What will be the role of the various governments involved? What will be the role of intra-European political structures like EEC and WEA? There are many such questions that deserve systematic exploration.

Table 4.12

AVIATION RELEVANT CONCERNS OF DEVELOPING NATIONS*

Concerns	Asian Nations (N-12)	African & Middle East (N-25)	Latin American Nation (N-7)	All Nat. (N-44)
Developing Infrastructure	66%	84%	71%	77%
Equal Share In Air Traffic	16%	8%	0%	9%
Expansion of Market	8%	4%	14%	6%
Economic Development Through Aviation	41%	16%	14%	22%
Politics of Aviation	33%	28%	28%	29%
Regulation of Market	16%	12%	0%	11%
Concern of Environmental Impact	8%	4%	0%	4%

* Based on a thematic content analysis of the excepts from the speeches of the delegates to the 22nd Assembly of ICAO, Montreal, Sept. 13 - Oct. 4, 1977.

Note: Percentages total more than 100% due to multiple themes identified in the speeches of most delegates.

Concerns of Certain European
National Elites in the Area of
Western European Defense Policy
(asterisk where concern exists)

Themes Emphasized as Rationale for Collaboration in Defense Production

Nation	Budget Cuts	R & D Costs	Imports from U.S.	Excessive Overseas Sale	Balance with Warsaw Pact	Common Security Policy	Transatlantic Competition	National Independence	European Competition	Standardization	Energy Crisis
Britain	*	*	*		*		*	*	*		
France	*	*	*	*	*	*	*	*			
West Germany	*		*		*	*			*		
Belgium	*	*			*				*	*	
Netherlands	*		*		*	*				*	
Luxembourg	*		*		*					*	
Italy	*	*			*		*			*	*
Norway	*				*					*	

Source: A thematic content analysis of the official record of the symposium on European Armament Policy, 3rd-4th March 1977

Table 4.13

4.5.2. Concerns of the Third World Nations

United Technologies has studied the relevance of less developed nations to advanced aircraft transport (ref. 63). The findings of this study suggest the following conclusions:

(1) Most of the aircraft required by developing countries could be the same types as are used by the United States and other developed nations.

(2) While the needs of developing countries for large cargo aircraft are expected to be small compared with the developed countries, this market sector may represent an important supplement to the production base. Such optimistic suggestions have to be evaluated in the light of certain broader questions about the aviation relevant concerns of the third world nations. How do these third world nations perceive their role in the world aviation industry? Are they also concerned about the dominance of western countries (including the U.S.) in aerospace market? How are their orientations toward such questions likely to influence their willingness to accept the development of advanced cargo aircraft by the U.S.

It appears that most developing nations are primarily concerned about the cost of developing an infrastructure to support modern aircraft. A number of problems may be identified in this area. The delegates to the assembly seemed highly concerned about the cost of maintinaing such an infrastructure.

Secondly, considerable emphasis was placed upon what may be called "the politics of aviation". Among other concerns, the developing nations emphasized such problems as economic development, market expansion, market regulation, and the environmental impact of the expansion of general aviation.

Such analyses suggest that the developing countries may be a potential supplementary market for large cargo aircraft, but the politics of the third world might create some problems for marketing American aircraft in these areas.

4.6 FUTURE AND LONG TERM IMPACTS

We have said earlier in this report that we wish to avoid catastrophic failure through overcommitment of resources to the ACIS (Section 4.1). We have also said that the supply of cheap oil will be progressively depleted in the time period we are planning for (Section 4.2). We have not predicted that the world will "run out of oil" during this period. A better way of conceptualizing the situation is to consider that the most easily accessed oil will be used first. Gradually, the easily accessible deposits will become exhausted and even if oil is discovered, say at 15 000 feet under the sea, it may be that as much energy will have to be invested to reach this oil as will be returned by burning it. Oil may still be recovered under these circumstances but obviously it will be for some other purpose than fuel.

Similar "energy budget" reasoning applies to substitute fuels such as hydrocarbon derived from coal, oil shale, methane or methanol. The energy return from these sources will provide a much smaller margin over the energy cost than is the case for the easily exploited oil deposits which we are currently mining out. These substitute sources might, however, sustain a "low energy economy" and we must therefore consider this as one of our options.

The role of government is crucial in planning for the development of air cargo beyond 2015. The air transport picture beyond the period planned for in this report is unclear, because we do not know what sort of energy base we will have. This is crucial because the energy base will determine our economy and hence our transportation needs. In planning for the future, it is suggested that we consider three alternative economies -- a hydrogen fusion economy, a high technology solar power economy, and a low energy economy. These appear to be our possibilities. Since we are talking about planning for the future, we will not even discuss a do-nothing or muddle-through approach; this is not planning, and if we adopt it, there is no future, at least, for air cargo.

The hydrogen fusion option offers the greatest potential for development but entails the greatest risk. In a hydrogen fusion economy, the available energy would be almost limitless and almost free. As a result, the value of time would increase inordinately and the demand for a high volume efficient air transport system would be virtually assured. In this possible future, the only constraints to growth would be the amount of pollution people could tolerate; the space available for transport activity; and, political irrationalities. The catch is, maybe it cannot be done.

The high technology solar power economy would be less energy-rich than a hydrogen fusion economy. In addition, there would be more favored places entailed by the very technology undergirding such an economy; e.g., bands under satellite power stations, areas with higher levels of irradiation, and regions near the sea coast. The distribution of population would conform to these more favored places.

The air transport system would thus be constrained in two dimensions -- energy availability and population distribution -- and would play a modest role in the overall economy. If this is the chosen future, then the 1990 system will form an admirable base for further modest incremental growth and network modification.

We can imagine something like the following development: A network of approximately fifteen hubs is in place by 1990. This network is served between major hubs by a plane like the Boeing 747 or the C-5A. Sometime during the 1990-2015 period, a high energy solar economy first supplements and then supplants our current hydrocarbon economy. As world surplus gradually builds up, there is more and more traffic on the ACIS. When volume builds to the point where three or four planes are required each transit period between most of the hubs, it will then become a sound investment to build a fleet of distributive-load aircraft to replace the old long haul planes.

If this is how things turn out we might see a production run of 600 000lb payload spanloaders. Naturally, if these large craft are put into service, considerable investments will have to be made in airports and facilities. For a good preliminary description of the system sketched here, the reader should see reference 64. One design concept for a distributive load freighter is shown on the right in Figure 4.12. The design on the left represents a plane intermediate in size between the largest freighters now in service and the span loader.

If the low energy economy is the option exercise, then the picture is radically changed. There is still need for air transport in this alternative future but we are talking about a world where the pace of events will be slow and economic activities will have a greater degree of local orientation. In this foreseeable world, the use of lighter than air ships to move large volumes of low value commodities from the interior of the continents is quite likely to occur.

In an economy where conservation is emphasized, human and animal labor is substituted for power machinery, and commodities are stored for local consumption rather than transported, there will be a general decline in the efficiency of all land transport systems and air ship exploitation of markets remote from water transport will become attractive.

As world population rises toward nine billion persons in the early part of the next century, and as the trend toward concentration of people in urban areas continues, sheer congestion and degradation of roadways should make the small airship competitive with the truck for loads in the 20 tonne range. Such an airship would (a) cost less than a comparable lift plane, and (b) have a higher transport efficiency than a truck under the conditions described above. A good discussion of these efficiencies can be found in ref. 65.

In order to plan beyond the next equipment cycle, we need to know what kind of future we are planning for, because air cargo planning is directly dependent on energy planning. Sometime soon a definite commitment to the future will have to be made; we cannot hold our options open indefinitely.

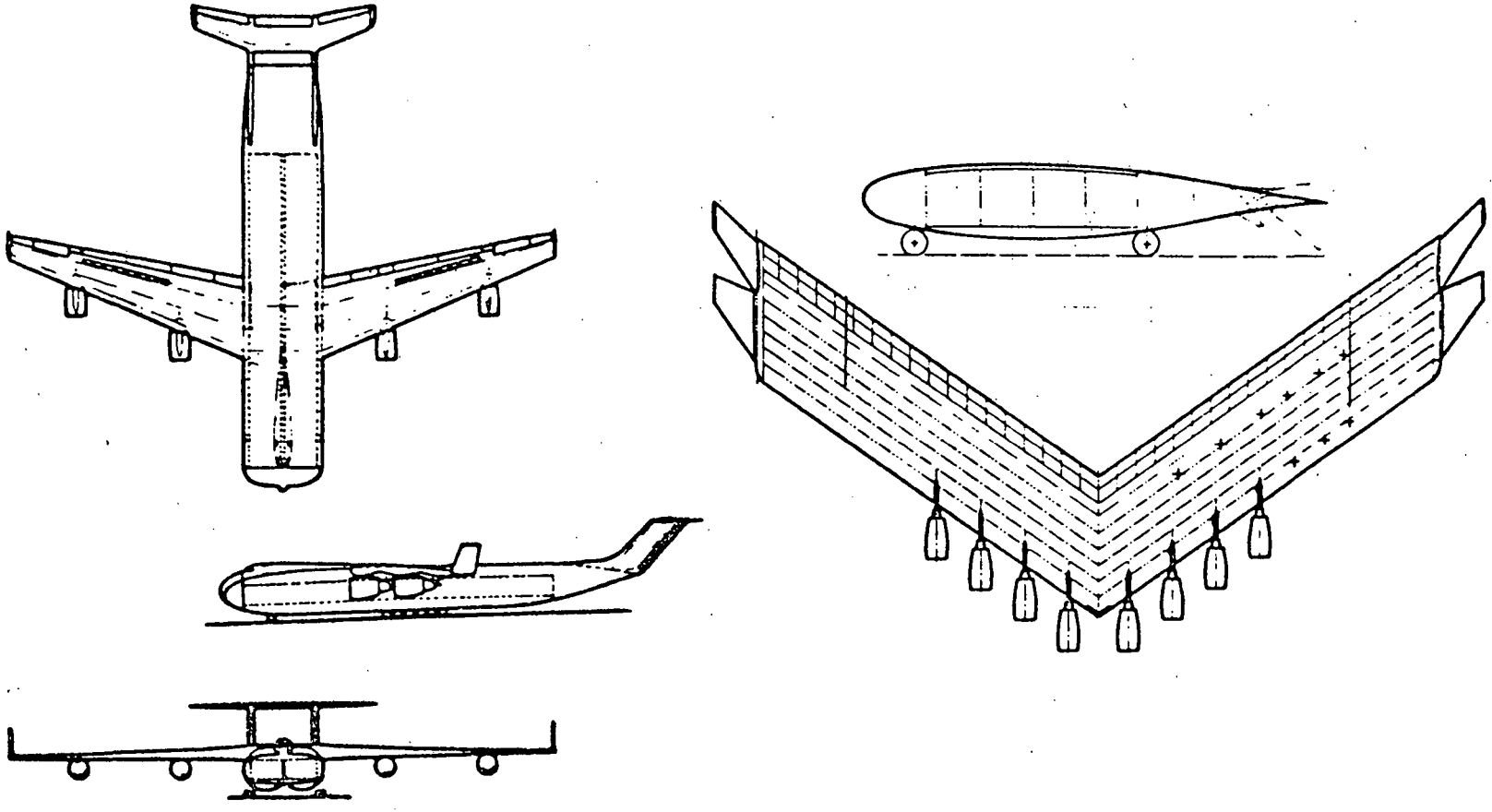


Figure 4.12 PROPOSED FUTURE AIRCRAFT (Sources: Whitehead, Allen: Technical and Economic Evaluation of Advanced Air Cargo Systems. NASA TM 78672, 1978, p. 20).

When we look toward the mid range future, we are quite optimistic about the prospects of air cargo. As long as a cosmopolitan form of social organization persists, whether the energy expended per capita is low or high, there should be a demand for freight moved by air. However, the level of energy expended will probably determine what kind of air transport is employed.

We now turn to a consideration of the long range pervasive impacts of the ACIS. The first of these is the impact of vertical integration. Vertical integration should result in labor efficiencies; thus, short term impact will be loss of payrolls in some areas. Furthermore, because integration will limit the number of competitors, some shippers may experience temporary loss of service. It is expected that these adverse impacts will in the main be of short duration and local in their affect.

If integration should work properly, cost-savings should result in higher earnings for the firms involved. Higher earnings should lead to lower rates for the same level of service or better service at the same rate. This should lead to economically healthy firms. Lower rates, better service, and a healthy air cargo system will be a stimulus to economic growth and will be beneficial to the whole economy.

Integration may also cause the economy as well as the air cargo system to attain a better balanced use of resources. Service by some modes would be decreased and service by other modes would be shifted from less productive uses to more productive employment. In the long run, labor, shipper, communities, and the general public would benefit from better uses of resources. The second long term pervasive impact we shall address is the ACIS second order social impacts.

A convenient way of thinking about what we shall call the secondary social impacts of the (ACIS) can be acquired by considering the predilection of many contemporary sociologists to turn to a new paradigm.

The new paradigm portrays individual humans as nodes in a network with each node having ramifying connections to many other nodes. In most instances, these networks are perceived by sociologists as having low degrees of connectivity. There is little feedback by way of intervening nodes to stabilize the network and hold the individual in a nexus of expectations. Beyond the direct "exchange" between parties, there is little effect on the parties to a social transaction.

When we ask why this paradigm is displacing the simpler paradigm of structural functionalism, derived primarily from anthropologists, with its implicit assumption of ramifying secondary feedlock loops, we reach a conclusion which may surprise some persons: The new paradign simply fits contemporary society better than the old one did.

What we are saying is that this is because the very nature of the ways human beings relate to one another is different than it was seventy years ago. Confronted with the modern scene the modern sociologists can, in most cases, only arbitrarily draw group defining boundaries and any normative order he

uses is of such a high level of abstraction as to convey almost no information.

Upon reflection, it is reasonable to expect that the ACIS will contribute to a continuation of the trend toward rendering the social life of Americans suitable to explanation only by means of network analysis. To the degree that it makes it possible for larger numbers of persons to interact impersonally with one another, it will help to create conditions which will make the network paradigm necessary.

The third long term impact of the ACIS, we perceive, is that in the international sphere it should tend toward generating interdependencies among the trading parties. It is quite possible that several nations could contribute items which form some complex assembly. This is easy to conceive at the outset, but it is only the tip of the iceberg; over time this interdependence could ramify throughout entire segments of the economy. We are here picking up another thread of the same fabric we were considering in Section 4.3 The message is the same in both instances; the ACIS is a force for interdependency; depending upon ones value system, this can be judged as either good or bad.

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